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ABSTRACT

This hearing presents the text of House Resolution 1134, related testimony, prepared statements, and supplementary materials. A statement by Tom Downey, a congressional representative from New York State and the introducer of the bill, is followed by a prepared statement, two articles, and testimony by Ludwig Braun of the Computer Science Department of the New York Institute of Technology. Braun discusses the need for the proposed national centers for microcomputers in education and their potential impact; identifies some of the ways in which a proper computer environment could enrich learning experiences; describes some special features available for microcomputers for working with handicapped students; and urges a national commitment to ensuring that students in all school systems have access to computers. In his prepared statement and testimony, Kyo R. Jhin, Assistant Superintendent for Educational Technology for the District of Columbia Public Schools, describes the ongoing integration of computer technology into that school system. A prepared statement and testimony by Philip Speser, President of the National Institute for Entrepreneurial Technology, focus on the need for computer literate workers, the inability of the school to meet this need, and the interest of small high-technology firms in this legislation. (LMM)

HEARING ON NATIONAL CENTERS FOR PERSONAL COMPUTERS IN EDUCATION

ED238393

HEARING

BEFORE THE

SUBCOMMITTEE ON ELEMENTARY, SECONDARY, AND VOCATIONAL EDUCATION

OF THE

COMMITTEE ON EDUCATION AND LABOR HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

FIRST SESSION

ON

H.R. 1134

TO AMEND TITLE III OF THE ELEMENTARY AND SECONDARY EDUCATION ACT OF 1965 TO PROVIDE FOR ONE OR MORE NATIONAL CENTERS FOR PERSONAL COMPUTERS IN EDUCATION

HEARING HELD IN WASHINGTON, D.C., ON APRIL 21, 1983

Printed for the use of the Committee on Education and Labor

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HEARING ON NATIONAL CENTERS FOR PERSONAL COMPUTERS IN EDUCATION

THURSDAY, APRIL 21, 1983

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ELEMENTARY, SECONDARY,
AND VOCATIONAL EDUCATION,
COMMITTEE ON EDUCATION AND LABOR,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:40 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the subcommittee) presiding.

Members present: Representatives Perkins, Miller, Ackerman, and Packard.

Staff present: John F. Jennings, majority counsel; Nancy Kober, legislative specialist, and Richard DiEugenio, minority senior legislative associate.

[Text of H.R. 1134 follows:]

98TH CONGRESS
1ST SESSION

H. R. 1134

To amend title III of the Elementary and Secondary Education Act of 1965 to provide for one or more National Centers for Personal Computers in Education.

IN THE HOUSE OF REPRESENTATIVES

FEBRUARY 1, 1983

Mr. DOWNEY of New York introduced the following bill; which was referred to the Committee on Education and Labor

---

A BILL

To amend title III of the Elementary and Secondary Education Act of 1965 to provide for one or more National Centers for Personal Computers in Education.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title III of the Elementary and Secondary Education Act of 1965 (20 U.S.C. 2941 et seq.) is amended by adding at the end thereof the following new part:

"PART N—COMPUTERS IN EDUCATION

"PROGRAM AUTHORIZED

"SEC. 393. (a) Subject to the availability of funds to carry out this part, the Secretary shall award grants for the

establishment and operation of National Centers for Personal Computers in Education (hereinafter in this part referred to as a 'Center') to instruct students in the use of personal computers and to develop programs designed to utilize personal computers and microcomputers as educational tools at all educational levels. No grant may be awarded under this part except to a person or entity which has submitted an application under section 394 which has been approved by the Secretary. Any grant awarded under this part shall, subject to the availability of funds under this part, be sufficient to permit the recipient to operate a Center for a three-year period beginning with fiscal year 1982, subject to the determination by the Secretary at the end of each fiscal year of operation of a Center that the recipient has complied with the assurances contained in the application for the grant.

"(b) The responsibilities of any Center funded under this part shall be to—

"(1) identify sources of courseware materials and provide information about such materials to interested parties;

"(2) develop courseware materials for use in areas in which available courseware materials are inadequate;

"(3) identify and develop curriculum materials for instructing students at all educational levels in the uses of computers;

"(4) provide special teacher training and demonstration computer systems to schools at all educational levels that have a large proportion of minority students;

"(5) develop methods for enabling handicapped individuals to use computers for communication and educational purposes;

"(6) conduct programs demonstrating the various educational uses of computers which shall include, but not be limited to—

"(A) the provision of computers in the classroom for student use which may include as many as one computer per four students,

"(B) the establishment of a laboratory that uses computers to simulate live experiments, and

"(C) the establishment of a computer library that would allow students to borrow personal computers for use outside the classroom;

"(7) assess the relative quality and merits of commercially available microcomputers and disseminate such assessments to educators;

"(8) monitor new developments in educational technology, including microcomputers and video disc systems, and disseminate information about such developments to educators;

"(9) develop teacher training materials, including computer programs, films, slides, pamphlets, and audio and video cassettes, that will—

"(A) instruct educators about personal computers and their uses to enable them to determine the amount of financial resources and personnel to commit to the use of computers in their educational system,

"(B) instruct educators in the methods of using computers to enhance the learning experiences of their students in the classroom, in laboratories, and at home, and

"(C) instruct teachers in computer programming and in the development of courseware materials;

"(10) establish a demonstration laboratory to exhibit examples of personal computer systems and courseware materials to enable educators to personally observe the operation of such computers and courseware materials;

"(11) publish a periodic newsletter to disseminate information on computers, computer training programs, and courseware materials;

"(12) assist Congress and interested Federal agencies in developing a program for establishing regional centers for personal computers in education, that shall include, but not be limited to, appropriate goals and designs for such centers;

"(13) solicit from subscribers to the newsletter established under paragraph (11) of this section information concerning their computer education needs;

"(14) assist Congress and Federal agencies in identifying areas in which Federal funding will accelerate the educational impact of emerging computer technologies;

"(15) undertake any studies requested by Congress or Federal agencies relating to educational uses of computer technology;

"(16) establish a mechanism to inform the computer industry of the computer needs of the Nation's educational system and to receive from the computer industry information concerning recent developments in computers;

"(17) monitor developments in the area of intercommunication among users of personal computers and

devise means of utilizing intercommunication to inform educators of the potential uses of personal computers;

"(18) assist interested local libraries in establishing programs to provide personal computers and video disc systems to the public; and

"(19) establish a model community personal computer center in one local shopping mall which shall—

"(A) provide a site for field trips by groups of local students,

"(B) provide demonstrations of the educational uses of personal computers to patrons of the mall,

"(C) conduct courses for community residents on the operation of personal computers, and

"(D) provide computer programs and books, magazines, and other information about computers on loan to the public.

"APPLICATION

"SEC. 394. Any person or entity desiring to receive a grant under this part shall submit to the Secretary an application for the establishment and operation of a Center. Applications under this section shall be submitted at such time, in such form, and containing such information as the Secretary shall prescribe. An application shall not be approved unless it—

"(1) provides that the Center will be administered by, or under the supervision of, the applicant;

"(2) provides for the performance of the responsibilities described in section 393(b);

"(3) sets forth policies and procedures that will ensure adequate evaluation of the performance of the Center;

"(4) provides for such fiscal control and fund accounting procedures as may be necessary to assure proper disbursement of and accounting for Federal funds paid to the applicant under this part; and

"(5) provides for making an annual report and such other reports in such form and containing such information as the Secretary may reasonably require and for keeping such records and affording such access thereto as the Secretary may find necessary to assure the correctness and verification of such reports.

"REPORT

"SEC. 395. Each recipient of a grant provided under this part shall transmit a final report to the President not later than January 1, 1987. The final report shall contain a detailed statement of the activities of the Center operated by the recipient, together with recommendations of ways to use personal computers to improve the educational system of the United States.

"DEFINITIONS

"SEC. 396. For purposes of this part—

"(1) the term 'courseware materials' means educational materials for use with personal computers and includes, but is not limited to, computer programs and student-teacher workbooks that provide—

"(A) simulated laboratory experiences in the natural and social sciences,

"(B) discovery learning in mathematics,

"(C) drill and practice in communications, mathematics, and science,

"(D) educational games that provide learning experiences, and

"(E) materials to develop problem-solving skills in mathematics and science;

"(2) the term 'microcomputer' means a digital computer constructed primarily of microelectronic components;

"(3) the term 'personal computer' means a microcomputer that is portable, costs less than $2,000, and needs only an electrical outlet for use; and

"(4) the term 'computer' means a microcomputer or a personal computer.

"AUTHORIZATION OF APPROPRIATIONS

"SEC. 397. There is authorized to be appropriated to carry out the provisions of this part $4,000,000 for the fiscal year ending September 30, 1984. Sums appropriated under this section shall remain available until September 30, 1986."

Chairman PERKINS. The committee will come to order.

This morning the Subcommittee on Elementary, Secondary, and Vocational Education is conducting a hearing on H.R. 1134, a bill introduced by our colleague, Tom Downey, to create National Centers for Personal Computers in Education.

The legislation authorizes $4 million for support of one or more centers to instruct students and teachers in the use of computers and to develop programs facilitating the application of the computers in the schools.

We are pleased to have with us Congressman Tom Downey and a panel of knowledgeable witnesses.

We welcome you here, Mr. Downey, and proceed any way you prefer.

Mr. DOWNEY. Mr. Chairman, I want to thank you very much and I also want to thank my newest colleague from New York, Mr. Ackerman, for coming as well. We are looking forward to great things from him in our delegation.

STATEMENT OF HON. TOM DOWNEY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK

Mr. DOWNEY. Mr. Chairman, there's no more powerful an idea than an idea whose time has come, and I believe that H.R. 1134 is such an idea. I appreciate the opportunity to testify on its behalf today.

I have introduced this bill, which, as you mentioned, would provide for the creation of National Centers for Personal Computers in Education.

The bill establishes a grant program to be administered by the Secretary of Education. Recipients of the grant would operate the Center for a 3-year period, after which they would report to the President on the activities of the Center, together with recommendations on ways to use personal computers to improve the educational system in the United States.

Personal computers are already being used in schools. A 1980 Office of Technology Assessment Survey indicated that one-half of all public institutions on the secondary level, 14 percent of those on the elementary level, and 19 percent of the vocational, special education and other types had one or more computer terminals available for student use.

Yet despite this start, successful integration of computers into the classroom is impeded by many obstacles. For example, few teachers or administrators are trained in the instructional use of computers or other electronic media. Unsound decisions in implementing technology and selecting curriculum packages could be extremely costly to schools. Money has already been wasted, and potential benefits could be lost. Further, exaggerated expectations or a bad initial experience could lead to disillusionment with educational technology and to significant delays in its appropriate implementation.

H.R. 1134 attempts to help educators avoid these pitfalls. The 19 responsibilities of the Center listed in the bill all serve to achieve two broad objectives: First, to operate a pilot project to build up data and expertise on the best ways of integrating microcomputers

into a classroom setting; and second, to act as a research and reference center for educators and libraries throughout the United States.

I would like to touch on a few of the Center's functions so that the committee has a clearer understanding of just how educators would be helped. But first I want to emphasize that this bill is not a public subsidy to schools to help finance the cost of installing computers. Rather it could be viewed as a sort of Congressional Research Service on computers for educators.

An extremely important role to be played by the National Centers would be to identify existing educational computer programs and develop new education courseware. In the OTA Assessment 1982 report entitled, "Informational Technology and Its Impact on Education," the lack of educational software was the most oftencited barrier to current educational use of technology. The following is a quote from the report:

> An industry-sponsored study conducted in 1980 identified some 304 educational software developers. Although these numbers would seem to suggest that the educational courseware business is thriving, this is not the case. There is considerable skepticism, especially within the software industry, about the school market and its potential. Some hardware and software firms have developed authoring systems for use by educators, but commercial courseware now available does not meet many of the needs of the local school systems.

As in the development of the TV program "Sesame Street", which, I might add, Mr. Chairman, my 2½-year-old daughter and my 1-year-old son seem to thrive on exclusively, Federal support can result in benefits that may not otherwise occur. The National Center could be very helpful in reducing the risks that currently inhibit major investment in quality courseware.

Additionally, good software may be more forthcoming if producers see a sufficient quantity of hardware in the schools to provide them with a viable market.

A second major function of the centers will be to develop teacher training materials. One of the biggest obstacles impeding the successful integration of computers into schools is that teachers don't understand computers. Many students know more about computers because they play PAC-MAN at the arcade than their teacher will ever know.

Widespread use of technology in the classroom requires that teachers be trained both in its use and in the production of good curriculum materials. Too few teachers are so qualified today. In a recent NEA survey, Mr. Chairman, less than 20 percent of the teachers had any computer training at all. I don't need to tell you in this committee that schools are already faced with a shortage of qualified math and science teachers. You have already explored that indepth.

Further the OTA study indicated that there is little evidence that the teacher training colleges in the United States are providing adequate instruction to new teachers in the use of information technology.

A third role played by the National Center would be to monitor and disseminate new materials in educational technology. The information industry is the fastest growing industry in the country

and keeping up with the new developments in the field is difficult, to say the least.

"Scientific American"—and I always love these analogies—stated that if the aircraft industry had evolved as rapidly as the computer industry over the last 25 years, a Boeing 767 would cost $500 today and it would circle the globe in 20 minutes on 5 gallons of fuel.

The dizzying speed of the computer industry's evolution can be intimidating. Yet if the resources of a National Center were available, educators could keep up with this change. It would also free educators from being at the almost complete mercy of the vendor for information about new developments.

I would also like to say a few words about how the National Center For Personal Computers in Education fits into a bigger picture, one that every member of this committee is well aware of.

High technology innovations, such as computers and industrial robots, and the emergence of an increasingly service-oriented economy will dramatically change the kind of employment opportunities available in the future.

This explosive growth in the high tech area has been likened to the original Industrial Revolution—and with good reason. The unemployed auto worker in Detroit, or a miner in Montana, are the warning signs of the volcanic shift from the smokestack industries to the emerging high technology economy. Training our young people will be a necessary fact of life if the United States is to survive in an increasingly competitive world.

A recent Carnegie Mellon University Robotics Institute study concluded that the simplest, first generation robots now in use have the potential to replace about 1 million of the 9 million currently employed operating manufacturing workers.

The National Commission for Employment Policy's "Eighth Annual Report" estimated that close to 55 percent of all workers in 1980 were involved in some kind of information-related occupation. In 1981, when 10 million people were unemployed, 1 million skilled jobs went unfilled.

The Bureau of Labor Statistics predicts that three of four jobs will require some technical training beyond the high school level in 1990.

The following occupations were identified by the National Commission for Employment Policy as offering the best job prospects in the future—industrial robot production, energy technicians, industrial-laser processing, genetic engineering, and bionic medical electronics.

It will be very difficult for those who lack related education and training to find even entry-level jobs in automated industries.

Indeed, Mr. Chairman, just 20 years ago, those occupations were unknown to the vast majority of Americans.

The NCEP report also stressed that automation is imperative to the restoration of the country's industrial base. Our Nation's productivity growth rate has been substantially shrinking since the 1950's from 7.9 percent in 1950 to a negative 0.7 percent in 1980. Since growth in productivity is related to increasing skills of workers, education and training is important to solving the productivity problem.

In many ways, I feel as though I am preaching to the converted. The excellent work done by the Committee on Education and Labor in fashioning the Emergency Mathematics and Science Act indicates that you share my views on the importance of improving and updating the quality of American education.

The 1982 OTA study made four recommendations for Federal involvement in stimulating the educational use of technology. One of these four recommendations was almost an exact description of the National Centers for Personal Computers in Education bill. I feel that H.R. 1134 builds upon the base already laid by this committee and your foresight, and that it could be an important part of an effort to prepare workers for the future.

I thank you very much for listening to this statement.

Chairman PERKINS. Let me thank you, Mr. Downey. I am personally for your bill. But what type of agencies or institutions would be eligible to receive these grants to set up computer centers?

Mr. DOWNEY. Elementary and secondary schools and libraries would be eligible.

Chairman PERKINS. Now, there is some evidence that shows that students in richer school districts are more likely to be able to use computers in schools than in, for instance, the rural Applachia sections and how would your bill help poorer school districts, and especially poorer rural districts to make computers available to those students?

Mr. DOWNEY. Mr. Chairman, there is nothing specific in this bill that programs this money to be used in poor school districts over wealthy school districts. One of the advantages of the bill, and one of the things that we have seen, is that by providing across-the-board the availability of this service, poorer school districts, which continue to have less money, will not waste that money because the computer center would hopefully be able to educate them properly.

Chairman PERKINS. It has been my observation in the wealthier districts in my area that in some math classes in the elementary and secondary schools, we already have some computers and in the poorer schools, it is just unheard of. There is a discrepancy that we would like to bridge some way. I agree with you that we need these computers everywhere today.

Mr. DOWNEY. Mr. Chairman, if I might say, if you were to suggest amendments to the bill to target more money and make these centers more available to the school districts who need them more, I think that would be completely compatible with my strong feeling that the whole purpose of these Centers is to provide opportunities to children. And as you correctly point out, those in wealthier school districts usually have more opportunities, so I don't see anything incompatible with the committee effort.

Chairman PERKINS. In your opinion, the bill that you are handling to create a center to train teachers and students in the use of computers will accelerate to a great degree the use of computers in many of the high schools and elementary schools throughout the country?

Mr. DOWNEY. Yes, that's correct. It's axiomatic to point out at this point that computers are here to stay and they will grow in the school systems whether this bill is passed or not. The question

is whether they grow properly or not and whether or not the money issue is properly handled.

Chairman PERKINS. The $4 million that you propose is not going to do the job to start to cover the country but do you think this will serve as an incentive to cause the States and local school districts to get involved in a program of this type?

Mr. DOWNEY. I do, Mr. Chairman. You are going to hear from Dr. Ludwig Braun formerly from Stony Brook who is really one of the fathers of this legislation. He will further testify as to the amount. I serve on the Ways and Means Committee and before that on the Armed Services Committee. The amounts we are dealing with here are piddling compared to what I'm used to dealing with and if it required more money it would naturally be something that I would support strongly.

Chairman PERKINS. Mr. Miller?

Mr. MILLER. Thank you, Mr. Chairman.

Let's just put the Ways and Means and Armed Services Committees on notice that we've always been willing to pick those amounts up and make sure they get recycled back into human services. I want to congratulate and commend Mr. Downey for this legislation. I think that we have seen, all of us have witnessed on this committee, the rush toward embracing high tech as an answer to education, as an absolute necessity and also the concern expressed by many members of this committee that we will end up spending vast amounts on hardware, without either a suitable use of that hardware being made and/or whether or not the software would be of the quality so that we could start assuring schools that in many instances are buying hardware through the use of bake sales and car washes and everything else, that it would be put to a proper use. I think that we're already starting to see some very disturbing stories in the press of the computer that now sits idle, absent, perhaps, some game playing, and is not meetings it potential in terms of the students that it was designed to serve and I think that whether it's a national center or some other proposal that might evolve from this legislation, the dissemination and the quality controls on courseware are going to be absolutely essential along with some way of retraining teachers to embrace this.

I think they have now accepted that it was coming.

Mr. DOWNEY. Yes.

Mr. MILLER. There was great resistance because of fear or what have you. We have been here once before, a long time ago, with the production of hardware for schools that ended up not being used.

Mr. DOWNEY. Yes, that's right. My own experience with my own children and looking at this whole question of personal computers and how I might have one for them and whether I should buy one, is that you're really at the mercy, unless you're really an expert, of what the vendor tells you these computers can do. This problem is multiplied for a school district who has to go out and may have the money and decides, "Well, I'm going to buy the computers because it's happening," and they really don't have the vaguest idea how to integrate them or to use them.

I think it's essential to make sure that that money, that bake sale money, as you point out, George, is not wasted. I think it's ab-

solutely essential. And I think the opportunities for creativity are really limitless with this sort of thing.

Mr. MILLER. I also share the chairman's concern. Again, there was a recent account of which schools now have computers and it's pretty clear that schools serving low-income populations, rural populations, are simply left in the dust in the acquisition of both the hardware and the software. I don't know exactly how this national center addresses that but there's got to be some equilibrium or we're going to find out that the very children that the Federal Government has been most concerned about, the economically disadvantaged, are going to drop behind once again as we start to see them play catch up for the first time in 20 years.

Mr. DOWNEY. Well, the problem is even greater. We see evidence of that in societies that are advancing right into the 21st century and those that still plow fields with wooden plows. So I don't think that there is anything compatible with the idea that these things should be available to everyone and that the committee should do something extra to make sure that the poor school districts benefit from this technology. I think that's essential.

Mr. MILLER. We hope we would give this legislation a great deal of consideration because like everything else that we have done, and with the science and math bill and that whole effort, there has got to be some coordinated effort to assure quality and that people are not going to end up buying something they can't use.

Mr. DOWNEY. I just wanted to share with the committee when I introduced this legislation, I guess it was 5 years ago or 6 years ago. It languished and no one dared to follow up on it. All of a sudden it's almost like waking up and finding that I have won the Irish Sweepstakes. Actually, if it passes it's probably a lot better than winning the Irish Sweepstakes.

I thank my colleague from California.

Chairman PERKINS. Let me thank you very much.

Mr. Ackerman, go ahead.

Mr. ACKERMAN. Thank you, Mr. Chairman. I think this is great legislation and it probably is better than winning the Irish Sweepstakes. My concern is that $4 million in winnings in this case really isn't sufficient when it's divided around. It's not really going to make too many people happy.

I do want to echo the concerns that my colleagues have and we ought to look at these school districts across the country that have actually expressed some interest. We're going to be training the students, the young people in our communities. We're going to be training the youngsters in the wealthier school districts with the newer technology, and I think we have a potential problem of creating a bigger dichotomy than we have today.

Mr. DOWNEY. Yes, that's right. I welcome you, Mr. Ackerman, to the committee. Thank you. Thank you, Mr. Chairman.

Chairman PERKINS. Thank you very much, Mr. Downey. You're a good witness.

We will hear from a panel now, Dr. Ludwig Braun, Dr. Kyo Jhin, and Dr. Philip Speser.

We welcome you to the committee. We would be very glad to hear from you first, Dr. Braun. As usual, we will include your entire remarks in the record and you can summarize them.

[The prepared statement of Ludwig Braun follows:]

PREPARED STATEMENT OF PROF. LUDWIG BRAUN, COMPUTER SCIENCE DEPARTMENT, NEW YORK INSTITUTE OF TECHNOLOGY

DOWNEY BILL TESTIMONY--L. Braun, April 21, 1983

Thank you Mr. Chairman and Members of the Subcommittee on Elementary and Secondary Education for this opportunity to express my views on the Bill before you today. I should like to start by introducing myself.

I. My Background

I am a Professor of Electrical Engineering and Computer Science at The New York Institute of Technology on Long Island. I have devoted most of my energy, in the past twenty years, to advising, guiding, and supporting school people in the area of computers in education. Most of my graduate students in the past decade have been classroom teachers.

II. Are The Proposed Centers Necessary?

The central question which must be considered with respect to this Bill is "Are such Centers necessary?". I would like to suggest that the answer is "yes", for several reasons, which I outline below.

A. The Need

1. School People Need Help

School people are in desparate need of help in this area. This is clear, in my personal observation, from the number of invitations which I and my colleagues around the country receive to speak each year, from the number of letters and telephone calls each of us gets with requests for help, and from the number of people enrolling in courses to try to catch up. In my case, I have addressed about 15,000 teachers and administrators on the subject over the past four years on applications of computers in education.

This hunger for help and information has spawned a network of volunteer-based support groups like the National Institute for Microcomputer Based Learning (NIMBL) in New York and the Computer Using Educators (CUE) on the West Coast, to name just two. It also has resulted in at least a doubling of attendance each year at sessions on computers in education held at professional meetings of educators.

2. The States Have Not Responded

The several States in the US--with the notable exception of Minnesota--have not provided the guidance which the school systems need. The proposed Centers can provide this guidance to the school systems as well as to the regions and States which they serve.

3. Aggregation Of Resources

The aggregation of resources, both intellectual and financial, by such Centers dramatically increases the level of development of ideas, demonstrations, training materials,and dissemination of information to the user community, compared to the present situation where each school district works independently, usually on essentially the same problems as many other districts. The Centers will be able to draw on the small pool of experts nationally to solve the problems in an efficient manner.

4. Foreign And Domestic Activities In Educational Computing

During the period from 1960 to 1974, the United States (largely through Federal agencies like NSF, NIE, and the Office of Education) led the world in exploring ways of using computers in the education of children. Our efforts were so successful that there was a steady stream of visitors from all over the world to see what we were doing and to learn about our mistakes.

These visitors came from Australia, England, Japan, Germany, France, and Jugoslavia, and other countries. In every case, they took careful notes and went back home to implement our ideas. The major result of these visits was that essentially all the countries which visited now have active national programs to bring computers into their classrooms, and a national commitment to make computers ubiquitous in their schools.

Great Britain has committed $25 million to development of computers in education; France has established a "10,000 Microcomputers in the Schools" program within which thousands of teachers already have been trained to use computers; Japan has an active program; Switzerland has many microcomputers in its schools; and, even behind the Iron Curtain, there is a great deal of activity, with Jugoslavia being the most active.

The United States had the edge in educational computing (and we still do), but, because we have not recognized the importance of this tool and have not made the national commitment which follows from that recognition, we are in danger of losing that edge, and of losing the race for technological leadership.

B. **The Potential Impact**

1. Intellectual Giants

As I have outlined in the attached paper, computers have the potential for turning our children into intellectual giants compared to us adults--if we use them wisely. This is just as true for those who are average or academically weak (according to traditional measures) as it is for those who are "bright"; in fact, there is evidence that students who are weak academically benefit more from computers than do those at the other end of the spectrum.

There now is a great deal of evidence that computers, applied intelligently, can increase significantly the rate of learning, the extent of learning, the motivation to learn, and the retention of ideas already learned, among students over the entire range of abilities which exist in our schools.

The most precious treasure that we have as a Nation is our children. We must do everything that we can to ensure that all of them achieve their potential. To do otherwise is to squander this resource, as well as being unfair to those children who now are left behind by the "system".

2. Handicapped People

Because computers now are very inexpensive and are enormously flexible, we can provide support systems for people with a wide variety of handicaps so that they, too, may participate fully in our society. The blind can read, the deaf can hear, the paralyzed can walk, the non-vocal can speak--if we wish to make it possible. The well-known Kurzweil Reading Machine and work with paraplegics on 60 Minutes and The Phil Donahue Show are only two examples of such potential.

Declaring that handicapped children must be "mainstreamed" isn't enough. It will not take much money to achieve these "miracles", but it will take a national commitment to achieve what is reachable now.

3. The "Haves" and the "Have-Nots"

Even though we are the wealthiest nation in the history of the world, we still have poor people among us. The computer is exacerbating an already existing gulf between children who grow up in affluent communities and those who grow up in poor ones. Even if one sets aside the question of fairness, and the question of waste of precious young minds, we cannot ignore the terrible social pressures which are building up, as we exclude some young people from access to meaningful and rewarding careers. We must make certain that each child has access to the new technologies so that s/he can achieve everything that God intended for that child.

III. What Must We Do Now?

In order for the United States to maintain the lead which our technological skill gave us in the first place, it will be necessary for us to make certain that our children develop their mental abilities to the maximum extent possible. That will happen only if we take advantage of every tool that will help teachers to help children learn. Principally, we must make the at least the same level of commitment as a nation as have other countries. H.R.1134 is an important step in that direction, but it is only one step of what must become a national program.

I HAVE A DREAM

by Ludwig Braun

(With sincere respect for the late, great Dr. Martin Luther King, Jr.)

I. INTRODUCTION

I have a dream that, in the richest country in the history of mankind, we will recognize that our most precious resource is not our oil, our water, or our iron ore, our industrial production and GNP, or the strength of our defensive forces--but is our children, all of our children.

I have a dream that this most blessed by God of all lands will make the national commitment needed to realize the potential of each child and will make the commitment to using computers in the education of all of our kids, a commitment which already has been made by every other reasonable nation in the free world.

I have a dream that we finally will use computers in clever (rather than pedestrian) ways to enhance the intellectual development of all of our kids. Unfortunately, we can perceive the extent of this development only dimly.

Are these the speculations of a zealot, or of a fevered brain? Perhaps, but the potential for humanity of this dream is so enormous that it must be considered seriously.

It is the purpose of this paper to identify some of the ways in which a proper computer environment will enrich the learning experiences of kids (from ages 3 to 73) and to encourage a national commitment to the achievement of the objective of realizing the maximum potential of each individual (each of whom is precious to society as a whole).

Let me tell you about my dream.

II. SOME CLEVER WAYS OF USING COMPUTERS WITH KIDS

It would be presumptuous of me to attempt to list all of the ways in which computers can be used to generate new and exciting learning environments, but I shall describe at least a few briefly.

Before we get into specifics on clever ways of using computers, I want to make one central point about using computers in education. We should use computers whenever they can enhance the learning experiences of kids, but we never, ever should use them to replace ditto stencils or textbook pages! As we design courseware or look at material developed by others, we must ask ourselves, "Can this be done as well on print?" If it can, we have a piece of pedestrian material, and we should reject it. Unfortunately, with too much of the present commercially available courseware, the answer is "Yes"!

Let us turn our attention now to some of the ways in which computers are being used effectively to create exciting and effective learning environments for kids.

A. Game Playing

Game playing is considered by some to be a waste of the time of the children involved and a waste of precious computer resources. While I shall not attempt to defend the space-wars games (even though they are defensible in at least some circumstances), I am not willing to ignore the enormously valuable learning experiences that are possible with a properly developed game.

The potential of fantasy and adventure games for developing problem-solving skills is largely unexplored, but

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their basic technique of presenting the "player" with choices and with finite resources forces that person to make decisions whose level of complexity is significantly higher than that of the typical word problem used in an algebra course. Perhaps students actually will want to learn problem-solving techniques if they are allowed to enjoy the learning process.

More generally, if a learning experience is embedded in a game, students sometimes are motivated far beyond the level they expect of themselves. One excellent example of such a game is "Green Globs," which was developed by Sharon Dugdale and her colleagues at the University of Illinois. In this game, students develop surprising skill at constructing polynomials with specific characteristics.

Some people think of the term "game" as a pejorative one. It need not be so. Games that teach are perfectly acceptable--indeed, they are desirable as part of the total learning environment of the student. They even demonstrate that learning can be fun, after all.

B. Word Processing

One of the major failings of our educational system is the inadequate way in which we train our young to write. One reason for this inadequacy is that writing is perceived (correctly) by most students as a chore. Writing has two parts: the development of a set of ideas to convey to someone else; and the mechanical transcription of these ideas onto paper. The first is the interesting (and intellectual) part; the second is a chore--yet we seem to concentrate, in our instruction, on the

mechanics. It is these very mechanics that turn most people off to writing.

Fortunately, with the advent of inexpensive, yet powerful, word processors for all of the major micros (complete word processing systems that are effective with children can be purchased currently for as little as $1,000), we now are in a position to eliminate the tedious part of writing and permit our students to participate in the joyful part of writing. In my opinion, word processing will be perceived, in the future, as one of the most important applications of computers in learning environments.

C. Discovery Learning

One area in which the computer offers special capabilities is in discovery learning--learning where the student builds understanding (here, I mean gut-level, intuitive understanding) of a subject by direct, personal exploration. We build a significant amount of such learning into our educational system by providing laboratories in high school and college science courses, but do very little in this direction in the social sciences or in mathematics. One way of looking at computers (a way suggested to this author many years ago by Dr. William Huggins of Johns Hopkins University) is to think of them as lumps of clay, which we can mold to suit our desires, or as a universe, which we can create with any set of rules we wish to define. If we wish to have randomness, it is there; if we wish to leave it out for pedagogic reasons, we do so. We may or may not have friction (linear or nonlinear); any gravitational law

we wish; any supply-demand relationship we want; Mendelian or non-Mendelian genetics; a political system that is democratic to any degree we wish; populations with reproduction and mortality rates that we determine; or patients with any disease complexes we want our students to explore.

In the natural and social sciences, such discovery learning experiences that are implemented in a computer are called simulations. They permit students to ask "what if" questions. There is substantial evidence that such experiences, in supplementation of, or in place of, real-world experiences can enrich learning significantly. Simulations are useful whenever the real world is inaccessible because of time, complexity, danger, or expense. They are used in some environments to prepare students to conduct real-world experiments (this was done very effectively, for example, with the training of the astronauts in the Apollo Program).

Discovery learning through computers has equal merit in mathematics instruction. Many students are disenchanted prematurely with mathematics by the essentially theoretical nature of conventional instruction in the subject. There has been little exploration of discovery learning in mathematics, especially at the higher grade levels, but it seems likely that a student who discovers the convergence of some function to a limit will understand concepts in calculus more thoroughly than most students now do. A student who has the opportunity to experiment with probabilistic phenomena in a carefully designed computer simulation will have a better intuitive grasp of the phenomena that occur in a queue than will a student who is

instructed only in the axioms of probability, or who picks black and white balls out of urns (as I did when I was a student). A student who can explore the shape of a graph as a function of the parameter values or of the nature of the relationships among variables is likely to have a deeper understanding of concepts like maximum, minimum, point of inflection, function, etc., than a student whose only experience is in the conventional mold.

D. Information Processing

Most people think of computers as devices that do computations. That is true, of course, in a sense; however, in a much broader sense, computers are information processors (with numbers being only one kind of information which we want to process). Modern microcomputers, operating in a stand-alone mode, or communicating with a larger machine over telephone lines, permit us to access and manipulate large data bases and to carry out explorations of information that are far beyond the capabilities of almost every one available only a couple of years ago. Our ability to access Compunet, Medlars, stock-market information, Teletex, The Source, and other such information systems, is just at the early stages of development, but the rate of growth of such data bases and the increasing ease of access to these sources of information combined with decreasing costs suggest that this mode of utilization will become very important for us all in the very near future. One can't help but speculate that the "encyclopedia" salesperson of the future will try to sell eager

parents a subscription to a data base system designed for students, rather than a set of books which are static in their knowledge base.

E. Computer Programming

Computer programming is widely thought of as a superb vehicle for developing problem-solving skills and for developing intellect. The extensive writings on this subject by Dr. Alfred Bork of the University of California at Irvine, Dr. Arthur Luehrmann of Computer Literacy, and Dr. Andrew Molnar of the National Science Foundation illuminate this application far better than I could, and, so, I shall refer the reader to them for elaboration.

Probably three quarters of all the instructional computer time used in pre-college schools is used to teach programming, so it appears to be unnecessary to argue that this mode is important. There is, however, one point that needs to be made on this subject. There are many who argue that this or that language is "the only one that we should use." I even have heard people say that they would rather that kids didn't learn programming at all, rather than have them learn to program in BASIC or some other language. In my opinion, the important thing that we must do is to teach students proper programming concepts and techniques--regardless of the language used. Students who learn to program well in any given language have had a far richer learning experience than students without that exposure.

F. Handicapped Kids

In the past, handicapped kids have been shortchanged by our educational system, largely because it wasn't possible, within a reasonable budget, to provide good learning environments for these kids. Fortunately for these kids, and for all of society (which stands to benefit from the contributions of these kids), the advent of the inexpensive, but powerful, microcomputer has changed the picture here in sometimes dramatic ways.

Dr. John Euhlenberg at Michigan State University has used computers to provide a mechanism for artificially producing speech for students with cerebral palsy. These students have been able to communicate in a normal manner with others and, in some cases, have been able to succeed in a university program where speaking is required.

Mrs. Judith Beckerman, of the Commack School District on Long Island in New York, has had dramatic success with her junior high learning disabled students; she has provided them with access to word processing. These students, who previously had dreaded going to school, now are excited about school, and many are planning to go on to college.

In the spirit of this paper, it may be better if I describe some of the ways in which computers can help handicapped kids, rather than to cite additional examples of such applications. The modern microcomputer can provide a voice for those who cannot speak. It can (with appropriate additional circuitry) permit students who cannot move their fingers, hands or arms, to "strike" the keys of a computer keyboard. It can

(to a limited degree--with continuously expanding horizons) "hear" for those who are deaf. It can "see" for those who are blind. There is no handicap of which I am aware that cannot be overcome by clever, caring people who are provided with funds and support through the medium of the microcomputer.

Imagine a cerebral palsied person, or a person with other neuromuscular disorders, being able to play music and even create music, although that person cannot hit the keys of a piano or operate the valves of a clarinet. Imagine such a person being able to create a "painting" or other piece of visual art.

Imagine a person who cannot see who, nonetheless, can "read" laboratory instruments or who can read a book off the shelf of a library (as is possible now with the Kurzweil Reading Machine).

All of these things and more are possible with existing technology. We need only to make the commitment of resources and time to reap the enormous benefit to be expected of fulfilled human beings who are able to accomplish more than anyone would have dreamt possible a few years ago. Much already has been accomplished without funding. If adequate funding were available, we could accomplish miracles.

G. Music and Visual Arts

A dimension of modern computers in education that few people yet recognize is that of expanding the horizons of young people (and even some of us oldsters) in music and the visual arts. Capabilities that, until recently, were available only on

very large, very expensive computers, now are available on machines that cost less than $400.

As in writing, making music requires two components of talent--cerebral and mechanical. Most of us have the cerebral ability to make music (we all have had the experience of having melodies run through our minds), but most of us have some difficulty with the mechanical aspects of music (the generation of rhythm, the spanning of sets of keys on a piano, the formation of precise notes on a trumpet, etc.). This is especially true: among young children who do not yet have well-defined motor skills and who have trouble with the timing control required; among handicapped people with physical or neuromuscular difficulties; with our elderly whose reflexes are slowed down and whose joints may not work well anymore; and with the legions (like me) who just do not have these skills. All such people have been denied the pleasure of making music with anything but a radio or a record player, until now.

With computers as inexpensive as the Atari 400, the VIC 20, and the Radio Shack Color Computer, it now is possible for anyone to learn how to make music--indeed, to experiment with creating music.

With these computers (and many others), it is possible to tell the computer which notes you wish it to play, in what order, and how long to hold each note. This can be done as slowly as the user requires, since the computer stores the notes in its memory until instructed to play them. At that point, the computer plays notes and chords as the "player" desires. The player doesn't have to be able to form the notes

as in a wind instrument, or be able to generate the timings that are central to the rhythm of the piece. All of these are taken care of by the computer as long as the player has entered the instructions properly.

It even is possible for the user to specify the overtones, attack, sustain, and decay, note by note to create music on any "instrument" of his or her choice, whether that instrument is a real instrument like the piano or the clarinet, or some instrument which does not exist in the real world. Clearly, such power will enormously expand the horizons of people who have musical talent, but it also opens a musical world to large numbers of people who never will play professionally, but who, nonetheless, will have a much enriched musical experience.

Similar experiences await us all in the visual arts. Many of us, as parents, were proud of our youngsters when they first were able to color in a coloring book and successfully stayed inside the lines. Most people never go much beyond that level, partly, at least, because they do not possess the mechanical skills required to convert their mental images into brush or pencil strokes. With relatively inexpensive computers it now is possible to create multi-color visual images with adequate definition for most purposes. Within a few years, we will be able to afford to provide computers that will be able to generate images which rival paintings in detail and which will give us all access to the pleasures now reserved to the truly talented. Again, the very young, the infirm, the handicapped, and those of us who "just don't have it" will be able to express ourselves visually in ways not open to us now.

My remarks in the preceding paragraphs should not be construed to imply that I think that we all will become artists, nor that there will no longer be a need for a Rembrandt or a Heifetz. I merely wish to suggest that these marvelous machines will open new opportunities for us all to enjoy and to appreciate the arts in a different way and to a different extent than ever was possible when the vast majority of us were relegated to the role of mere spectators in the world of the arts.

H. Very Young Kids

I frequently am asked by parents and by teachers, "At what age should children be exposed to computers?" I am no expert in early childhood development; however, I feel very strongly that no child is too young to be exposed to a computer who can reliably strike the keys on the keyboard. We already have computers that can talk and that can recognize spoken words, even though only to a limited extent at this time. We currently are able to permit inputs using light pens and digital tablets, which also permit very early access to a computer. When these capabilities are improved, even "pre-keyboard" children will be able to profit from computer use. In fact, while this paper was being written, Mattel Toys introduced Teach & Learn Computer, a system geared for children aged three to eight, which uses a touch-sensitive panel with colorful overlays.

The current availabilty of Seymour Papert's LOGO language on inexpensive microcomputers offers us the exciting possibility of permitting very young children to begin developing

programming ability and, perhaps more importantly, to have early discovery learning experiences in mathematics. The potential of these kinds of learning environments for the intellectual development of these children is enormous.

How strongly do I believe these things? Stongly enough that my two youngest grandchildren, Ricky and Christopher, were exposed to meaningful computer experiences before they started in school--strongly enough that my youngest grandchild Katharine, will have access to computers very early in her life, probably for her second birthday.

The generation of just-born children is the first of the new wave of intellectual giants (by present standards), and my grandchildren will be among them.

I. Girls and Computers

One of the largest untapped human resources that we have in the United States is our women. This situation is changing, but too slowly, especially in the quantitative disciplines (engineering, mathematics, etc.). The reasons for this are complex and involve social as well as educational matters. It does seem to me that proper exposure of young women (probably in elementary school) to meaningful computer experiences of the sort which I have described in the preceding paragraphs will provide the kind of internal assurance that many of these young women need to overcome all the pressures that push them away from mathematics.

In many schools where computers currently are available to students, mostly males cluster around the computers. We must

make serious efforts to change this, perhaps by having special sections of courses which are open only to girls, or by encouraging their parents to provide computers at home when this is possible within the family's finances.

The friendliness of computers and their unbiased approach (when programs are designed properly) will encourage girls to break out of their stereotypical roles and to move into disciplines that they currently consider to be out of reach. Such a change of attitude will enrich us all.

J. Poor Kids

I am frightened by one aspect of my dream--the exclusion of poor kids from participation. All over the United States, schools in well-to-do communities are being equipped with large numbers of computers. At the same time, in these communities, parents are purchasing microcomputers for their children to use at home. These children surely will grow into the emerging Information Society and will participate in it fully.

Unfortunately, there are many other children who are not so fortunate. They live in Appalachia, Harlem, Watts, and lots of other economically deprived areas. Their schools do not have enough money to include computer purchases in their budgets, and their parents cannot provide computers in their homes. These children will be left behind by the Information Society and, in their frustration, will generate enormous social unrest.

Aside from the question of social equity and our desire to avoid social unrest, there is the serious question of a waste

of another precious human resource in our great land--the waste of the lives of all these young people without the resources to break out of their trap.

Because of the dimensions of this problem and because it transcends state boundaries, we must address it at the national level. We ignore these children at the peril, and to the shame, of us all.

III. OUR RESOURCE

It is hard to believe that an argument must be made that our children are our most precious resource, but our present economic and political environment suggests that many do not appreciate this (to me) obvious fact. Clearly, the leaders of tomorrow currently are in our classrooms. We must, above all else, give these children the best education of which we are capable.

The leaders of the countries with which we are most seriously competing (Japan, Russia, and Germany) all realize this and have made significant commitments of national resources to achieve this objective. We can see it in their curricular structure, as well as in their commitment of funds, on a per-capita basis, to educating their young.

As part of their commitment to this goal, each of these countries (and many others, as well) has established nationally based and nationally funded efforts to bring computers into their classrooms and into the learning environments of their young people.

We, in the United States, have provided a significant part of the expertise that has gone into the planning efforts of these other nations--usually at no cost to them. I and many of my colleagues all over the United States have been visited by delegations from many foreign

countries. All these visits have had the purpose of learning about our successes and our failures. These teams have gone home and have implemented programs based on these visits and have begun to pull significantly ahead of us in computer applications in learning environments, while we, as a nation, have essentially ignored the wonderful learning environments achievable in a computer. As just one example of the unenlightened environment in which we exist, one need look only at the dismantling of the science education group at the National Science Foundation. This group has played a major role in bringing this country to [illegible] position of world-wide leadership in educational computing and was at the beginning of a new thrust into explorations of this learning medium that would have pushed the boundaries still further forward, when it was essentially totally dissolved.

The field still is young enough that it needs altruism, rather than profit, to provide the principal thrust for its future directions. It is poorly enough defined that we cannot depend upon the commercial marketplace to decide what kinds of materials teachers need and what kinds of experiences will be the richest for kids.

Since profit levels still are small, the private sector is not able to commit to the level of funding required to address the issues involved in providing computer accessibility for our children--nor are the individual states able to provide this accessibility since they lack the resources, both in funds and in people. The only reasonable solution is for the federal government to reassume its leadership role in this area. Are we, as a nation, ready to make this national commitment to bring computers into the hands of our children in effective ways--not only on their behalf but for our country? Only time will tell, but for the sake of my four grandchildren and yours, I hope so!

Computers in Learning Environments--An Imperative for the 1980s

I. The Computer and Education

The computer has had a role in education in the United States for two decades. Until recently its role has been a minimal one for a number of reasons. Among these reasons are:

A. The lack of adequate amounts of high-quality courseware.

B. A lack of training among teachers and administrators in the uses of computers in education.

C. The cost of providing computing, which frequently has been far beyond the budget even of the very interested school.

Because of the advent of LSI technology in this country, the last inhibitory factor above has been decreased dramatically. It now is possible for schools to buy quite powerful microcomputers at prices in the order of $500-1,000, with the possibility that, within the next five years, these costs will decrease by a factor of two. Now that the cost of computing is within the reach of most schools, there is an urgency to the elimination of the other two principal inhibitors cited above.

There are several compelling arguments in favor of immediate and dramatic intervention in our educational system in order to take advantage of the many benefits which the computer can contribute. Among these compelling arguments are:

A. Our educational system is widely perceived as being unsatisfactory. Among the indicators which lead to this feeling of dissatisfaction are:

1. The significant increases in the number of dropouts (in New York City, e.g., more than 40% of students drop out before graduating from high school).

2. An increase in the number of students who are below their grade level. Frequently such students fall further and further behind the longer they stay in school. This may be a contributing cause of increased dropouts.
3. Declining SAT scores and increasing numbers of failures in statewide tests such as Regents examinations.
4. Decrease in average daily classroom attendance among students currently enrolled.
5. Unacceptably high levels of youth unemployment, especially among minority youths.
6. Continuing decline in the education of our students in the sciences as measured by the recent NAEP studies as well as those of the National Research Council and the National Science Foundation.

   In a September 17, 1979 excerpt from Education Daily, it is noted that the whole question of scientific literacy is a problem for the country. The National Assessment of Educational Progress report shows a decline in science knowledge in school children of all ages and points out that in the nine-year-old group on a national basis, some 65,000 fewer of this group could answer the typical science questions in 1973 compared to 1970, while 70,000 fewer of the seventeen-year-old group could answer science questions correctly in 1973 than they could in 1970.
7. Increased concern about spiralling costs incurred by the requirement to "mainstream" handicapped students, as well as by introduction of programs for gifted children and children with learning disabilities. All of these problems are exacerbated by the general lack of training among teachers in dealing with these special students.

8. Unacceptable levels of failure in state-mandated competency tests for high school graduation.

In each of the indicators of need cited above, there is evidence that the computer can provide assistance to the teacher in addressing these needs. Such assistance typically is not available otherwise.

It was not possible, within the constraints of time and finances, to do a complete literature search to support the contention above that the computer can help in improving our educational system; however, some major items of evidence will be mentioned in the paragraphs below.

With respect to increasing attendance as a result of the use of the computer, two studies may be cited--one dealing with secondary schools in the District of Columbia (1) and the other dealing with community colleges in Ontario, Canada (2). A finding from the secondary schools in the District of Columbia was that at a tax cost to the public of $8.43 per student day, there was an increase in student attendance across the three pilot schools totaling $30,790 (from daily attendance revenues). This was based upon only 700 students in the pilot program. Extrapolating this to the proportion for the total number of students in all secondary public schools in the District of Columbia (approximately 24,000 students), conceivably such a productivity gain would be on the order of $1 million per year. In the case of the community college system in Ontario, the use of the computer lowered the attrition rate or, conversely, increased the attendance rate of students in remedial or basic math from a dropout rate of 60% with traditional instruction, to a rate of only 20% attrition with the CAI math. In terms of a dollar's gain or cost-productivity gain index, the amount of money per year on a province-wide basis is $9,600,000. The value of these two studies is that they demonstrate that use of the computer to aid instruction can result in a substantial gain in use of the tax dollar to education.

Other indicators come from a series of reviews on the value of CAI for achievement and time to learn in elementary and secondary education, in particular the basic skills of math and language arts. For example, Vinsonhaler and Bass (3) reviewed a series of elementary education drill-and-practice programs which compared the use of CAI to traditional instruction. Their finding was essentially that augmenting classroom instruction with CAI provides superior performance on SAT or MAT standardized tests. Other reviews of the literature include that by Jamison, Suppes and Wells (4) and another by Edwards, Norton, Taylor, Weiss and Van Dusseldorp (5), both of which support the notion that supplementary instruction with CAI led to higher achievement that occurred in traditionally taught students. In addition, the HumRRO project (1) found that in consumer math, the use of the computer to augment an already individualized course of instruction provided a significantly higher achievement record for the slower students over the so-called faster students. In this case, prior grade achievement scores and intelligence were unrelated to the achievement within the consumer math course. Rather, the use of the computer provided the basis for their improved scores.

The most recent review of the effectiveness of the use of the computer (6) yields similar results, that is, when the computer is used to aid instruction in the elementary and secondary school level, the achievement and/or the time reduction to learn materials is significantly improved. This covers the skills in elementary mathematics and in the language arts.

An additional review of 32 studies in simulation and adaptive testing provides further support for the notion that computer-based education can be an improvement over conventional educational methods. This study (7) performed by HumRRO for the Office of Technology Assessment is summarized in Table I. The

TABLE I

THIRTY-TWO STUDIES OF COMPUTERIZED SIMULATIONS AND TESTING

	Source	Time saved	Cost saved	Greater efficiency	Improved skills	Provision of training not previously available
S	Abernathy and McBride, 1978	+	+	+	+	+
S	Allen, 1976	+	+	+	+	+
T	Bejar et al., 1977	+	0	+	+	+
S	Bentz, 1975	+	–	+	+	+
S	Brown et al., 1977	+	0	+	+	+
S	Brown, 1977	+	0	+	+	+
T	Brown and Weiss, 1977	+	+	+	+	+
S	Buchanan, 1978	+	+	+	+	+
S	Ellis, 1978	+	–	+	–	+
S	Gregory, 1975	+	–	+	+	+
T	Guerra et al., 1977	+	0	+	+	+
T	Hansen et al., 1974	+	+	+	+	+
S	Johnson, 1976	0	0	0	+	+
T	Lippey and Partos, 1976	+	0	+	0	+
T	McLain and Wessels, 1975	+	0	+	+	+
S	Misselt and Carl-Hirnwich, 1978	–	–	–	–	–
S	Mockovak et al., 1974	+	–	+	+	(conventional – superior)
S	Ortansky and String, 1977	+	+	+	+	+
S	Puig, 1976					
	Tanks	0	+	0	0	–
	Aircraft carrier	+	0	+	+	+
	Weapons trainer	+	+	+	+	–
	Air traffic controller	+	0	+	+	–
	Automobile	0	+	+	+	–
	Airborne ECN system	+	+	–	+	–
S	Roberts, 1977	+	+	+	+	+
T	Seely, 1975	+	0	+	0	+
T	Vale, 1977	+	+	+	+	+
S	Willey, 1975					
	Dartmouth	+	0	+	+	+
	Ohio State	+	–	+	–	+
	University of Wisconsin	0	–	+	+	+
	University of Illinois	+	0	+	+	+
	University of Michigan	+	+	+	+	+
	Totals	+ = 27	13	28	26	25
		– = 1	7	2	3	7
		0 = 4	12	2	3	0

Key: S = simulation
T = testing
+ = positive results
– = no significant difference
0 = no results

SOURCE: Human Resources Research Organization, 1978.

Source: *Computer Technology in Medical Education and Assessment*, p. 25, (7).

majority of these studies shows savings in learner time to complete a course of study (as much as 50% savings), greater efficiency in terms of achievement per unit of time, improved skills and provision of instruction not previously available by the conventional method. As noted in the review, the studies cut across all levels of education and include training as well.

B. Because we are moving into an information age and because computers are becoming ubiquitous in our society, it is essential that we develop a computer literate society. Licklider (8) makes the observation that:

> The world is rapidly moving into the information age. In order to make the transition wisely and well, the public must understand information science and technology. People must master the technology or be mastered by it.

Molnar (9) comments:

> A nation concerned with its social needs and economic growth cannot be indifferent to the problems of literacy. If we are to reap the benefits of science-driven industry, we must develop a computer-literate society.

C. Computers will move into our homes and our schools whether anyone does anything to ensure their effective use.

This contention is underscored in a recent survey (10) by Creative Strategies, Inc., a market research firm, which indicated that school purchases of microcomputers will quadruple in the four years between 1978 and 1982. Their projections are that the unit purchases by schools on a national basis will grow from 26,700 in 1978 to 105,000 in 1982. Secondly, the estimates are that 70% of the demand will originate in elementary and secondary schools. Thirdly, a justification for the use of the microcomputer as opposed to the maxi-computer (i.e., the large time-sharing computer) according to their survey, is based upon decreased cost and increased ease of use. The PLATO system (the major one that is being marketed as a system today in the maxi-computer field for education) costs $10,000 per terminal and roughly $800 a month additional for

usage fees. A typical microcomputer system costs in the range of $500-2,500, depending upon the peripherals which are purchased with it.

It is imperative that computers enter our educational system in an orderly, intelligent manner in contrast to our experience with TV. In its infancy, TV offered educators an excellent learning tool. Unfortunately, we did not capitalize on its potential, and it was dominated by commercial interests and became the "wasteland" many people decry. Massive efforts by PBS with series like "Nova" and the Children's Television Workshop with "Sesame Street," although excellent demonstrations of the role that TV could play in education, have little overall impact because of the entrenchment of commercial interests.

If the educational community (including federal agencies and private foundations interested in education) does not move forcefully and soon to ensure proper support for teachers and students in making intelligent use of personal computers, computers will become the "wasteland" of the 1980s, being used for playing more and more sophisticated versions of Star Wars® games, instead of helping our young people to develop their intellects to the fullest extent possible.

D. Inequality of opportunity across the spectrum of our society.

For a wide variety of reasons, young people from our lower socio-economic levels currently do not obtain the same benefits from our educational system as do their contemporaries in middle- and higher-income communities. Already schools in the latter category are purchasing personal computers in large numbers (in several Long Island school districts, e.g., there is at least one personal computer in each elementary school), while inner-city schools are unable to find the funds to participate in this "revolution."

Every year which goes by widens the gap in preparation between the young people in these two groups at social, human, and economic costs which cannot be tolerated in a modern democratic society.

E. Our present educational system is a mature industry which cannot be improved even with massive infusions of funds.

The urgency of the need of our educational system for help is presented very effectively by Dr. Dustin Heuston, Chairman of the World Institute for Computer Aided Teaching.(11) He points out that:

1. Our current educational delivery system is mature--i.e., it is insensitive to additional investment. He feels that the system cannot be improved without the dramatic change producible only with new technologies.
2. The current educational delivery system provides about 15 seconds of personal attention per hour, and that proportion, with computers, can reach almost 100%.
3. He describes an intersting analogy which is instructive for all educators: "If this were 1478, the business of foundations and government would be to encourage the introduction of the book into the educational system, not to work with monks in monasteries to improve their manuscript production abilities by funding studies on handwriting legibility, the placement of candles for lighting, or the design of better pens or superior ink."
4. After many years of expensive efforts to improve teacher productivity and other aspects of the educational system, the system seems to have achieved its maximum effectiveness.

II. What Must We Do?

The evidence is favor of placing computers in our schools in massive numbers already is compelling, and is growing stronger every year. In addition, there is danger that we will lose our world leadership in this field. Most of the countries represented at the IFIP Working Conference on Computer Assisted Learning in September 1979 have a national effort in place to bring computers into their schools. (France, e.g., has a program called Ten Thousand Computers in the Schools.)

Dr. Sylvia Charp, of the Philadelphia School System, points out that, for at least a decade, visitors have come from many foreign countries, learned about our successes and failures, and have gone home to implement programs of their own. Especially within the past three to five years, these programs have been national in scope and have been funded at significant levels. During this same period, little funding has been available in the United States for such activities, and what has been available has had no focus.

Despite this lack of national commitment, there are a number of active efforts around the United States, including:

1. Bob Albrecht (the Dragon and Friend of Children), who is well on his way to turning Menlo Park, California, into Computer Town U.S.A.
2. Ms. Karen Billings and her Microcomputer Resource Center at Columbia Teachers College, which provides advice and hands-on experience for New York area educators.
3. This author and Ms. Jo Ann Comito and their Laboratory for Personal Computers in Education, which has been in existence for five years providing advice for educators nationally and which has developed a graduate program in computers in education, as well as a large number of courseware units.

4. Sylvia Charp, the "grand lady" of educational computing, who has more experience with the real world of computers in education than anyone else in the world.
5. Tom Dwyer, who, for over a decade, has been developing novel ways of using computers to provide learning environments for our young people.
6. Judy Edwards of the Northwest Regional Educational Laboratory in Portland, Oregon, who recently received a federal grant to establish a clearinghouse for microcomputer-based courseware.
7. Joyce Hakansson of Children's Television Workshop in conjunction with the Busch Gardens people is developing neighborhood parks with microcomputer halls to make such equipment easily accessible to children.
8. Arthur Luehrmann of the Lawrence Hall of Science, who has developed a variety of innovative ways of using microcomputers in a museum setting.
9. The staff of the Minnesota Educational Computing Consortium, which has established a statewide network of microcomputer users and has developed a large library of courseware.
10. Seymour Papert (the father of the LOGO language), who is conducting an exciting experiment with a group of children who are in an environment where each child has instant access to a personal computer at home and at school.
11. Michael Zabinski, who runs a summer overnight camp where kids learn about computers.
12. Karl Zinn of The Center for Research on Learning and Teaching at the University of Michigan at Ann Arbor, who serves as a source of information, courseware, and advice to school people all over the U.S.

11

Although each of the groups cited above is making important and continuing contributions to the field and although there is an informal communications channel among these people, there is no national focus and, in toto, inadequate funding to accomplish the tasks which must be carried out to achieve the goal of improving education using the computer.

The essential problem here is that the private sector (publishers and comouter manufacturers) is unwilling to commit resources at the level required because the market hasn't developed sufficiently to ensure profitability in courseware production; but until courseware is developed in sufficient quantities, school people are unwilling to commit their resources to the provision of computing power for their students--thus establishing a "vicious cycle" which will dissipate very slowly unless there is substantial intervention. Because of the magnitude of funding required to develop a market of sufficient size that the private sector will take over, such funds must come from the federal government.

This problem was recognized a decade ago, and efforts have been under way for several years to obtain federal funding to establish one or more national centers for computers in education. The earliest of these arose as a set of recommendations by the Carnegie Commission on Higher Education in 1972 (12), while the most recent is a bill (13) introduced into the House of Representatives by Long Island Congressman Thomas Downey.

Such national centers will serve the educational community by:

1. Keeping abreast of developments in information technology.
2. Advising educators about capabilities and limitations of hardware and courseware.
3. Training teachers in the uses of computers in learning environments.

4. Developing large amounts of high quality courseware and training teachers to develop their own.

A serious look at the levels of effort required to accomplish these purposes at a significant level reveals that funding levels of these centers must be $1M-3M per year.

In the present economic climate, such sums appear to be difficult to obtain, but when we weigh them against the cost to individuals and to the nation of loss of educational opportunity and inadequate intellectual development of many of our young people, the choice is clear.

III. Acknowledgements

Although this author takes full responsibility for the content of this paper, the ideas expressed herein emerged, in part, from a series of discussions during the fall of 1979 with Dr. Norman Kurland of the New York State Education Department, Dr. Robert Seidel of HumRRO, and Dr. Karl Zinn of The Center for Research on Learning and Teaching at the University of Michigan at Ann Arbor. This author gratefully acknowledges their contributions of ideas which helped him to formulate his own.

The author wishes also to acknowledge the assistance of the Alfred P. Sloan Foundation, which provided partial support for the ideas expressed here.

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April 1980

STATEMENT OF DR. LUDWIG BRAUN, OFFICE OF INSTRUCTIONAL DEVELOPMENT, NEW YORK INSTITUTE OF TECHNOLOGY, OLD WESTBURY, N.Y.

Dr. BRAUN. Thank you very much, Mr. Chairman.

I'm really pleased to be here today. Let me just say that I've been working for 20 years toward this kind of thing. I have been running around the country telling teachers about what computers can do for their kids and I really am pleased that I'm able to be here today.

I also am delighted to hear the expression from the committee of concern for people from disadvantaged areas. I'd like to suggest that item 4 of the 19 items specifically deals with that issue and I think that's a very important one.

I think that there is a tremendous gulf developing in our society that will rip us apart before very much longer. The haves are moving very rapidly into the information society and the have nots, as Congressman Downey pointed out, are still in an agricultural society, and that will create tremendous social pressures which we must address.

I think the central question is are the centers that are proposed in this bill necessary? I think the answer to that is a resounding yes. I've been running around the United States, as I mentioned, preaching about this. I, in the last 4 years, have personally addressed 15,000 teachers and administrators and it could have been 50,000 if there were two or three of me, because I get requests to come to school districts and to meetings of all kinds. I'm not the only one. There are many people who are in that situation now.

There are volunteer-based support groups in the United States to provide some help to teachers and administrators, but those support groups are really inadequate to the task.

Unfortunately, with the exception of Minnesota and perhaps Rhode Island in the United States, the States have not responded to the need of educators for assistance in this area, and that suggests that centers of this kind are necessary because the States just have not provided the leadership that is necessary here. In fact, in many cases the State education departments are going to local communities looking for help and guidance.

I think there is an importance in the aggregation of resources that would occur in such centers. It would draw together groups of people who have ideas about how to use these things and the intellectual and financial aggregation would generate symbiotic relationships that would be very important.

Another reason that I think that this bill is very important is that there's been a great deal of activity in foreign countries in this area in the past 5 years. In the period from 1960 to 1974 the United States was very, very active in this area. Since 1974 there has been no, essentially no, Federal support for this kind of thing and our activities in this area have languished, while those in foreign countries have been accelerating.

Three years ago I attended a meeting, an international meeting, in London of educators who are active in the area of computers in education and I found that essentially every country in the Western World was—had made a national commitment to bringing com-

puters into their schools. In Great Britain, for example, a year or so ago they set up a $25 million national program to develop computers in their precollege school system.

France has 10,000 microcomputers in the schools program and has already trained thousands and thousands of teachers in their use. Japan has a program. Switzerland and Holland have a program. Little countries, countries much, much smaller than ours, with much less resources than ours, have developed programs. Some of the countries behind the Iron Curtain have developed impressive national programs and I suggest to you that Yugoslavia is perhaps the most active of those.

The principal reason, I think, that this bill is important is that I see our young people as the most precious resource that we've got in this country. We could turn them into intellectual giants compared to any of us adults with this tool, if the tool is properly used.

There was a concern expressed by you a few minutes ago about the impact on kids in economically deprived areas. It appears that by and large the computer is beneficial to all students but it's especially beneficial to students who are ordinarily considered academically weak. The benefit to them is greater than the benefit to students who are considered to be bright, although those terms are difficult to identify.

I think that with handicapped people we have an opportunity to enrich their lives, to bring them into the mainstream of our society. We can make deaf people hear. We can make blind people see. We can make paralyzed people walk. You may have seen "60 Minutes" about a month ago. A Dr. Petrovsky at Wright State University is helping people to walk who are paralyzed.

Computers are not inexpensive and very flexible and can be used in many ways to help handicapped people.

By the way, I attached to my prepared testimony two papers which I have prepared which address the issue of how computers——

Chairman PERKINS. Thank you very much and your prepared statements will all be inserted in the record.

Our next witness is Dr. Jhin, Assistant Superintendent for Educational Technology, District of Columbia Public Schools. Go ahead.

STATEMENT OF DR. KYO JHIN, ASSISTANT SUPERINTENDENT FOR EDUCATIONAL TECHNOLOGY, DISTRICT OF COLUMBIA PUBLIC SCHOOLS

[The prepared statement of Dr. Kyo Jhin follows:]

PREPARED STATEMENT OF KYO R. JHIN, ASSISTANT SUPERINTENDENT FOR EDUCATIONAL TECHNOLOGY, DISTRICT OF COLUMBIA PUBLIC SCHOOLS

Mr. Chairman, Members of the Committee and my distinguished colleagues, on behalf of the Superintendent of the District of Columbia Public Schools, Mrs. Floretta D. McKenzie, I am pleased to join you here today to discuss some of the innovations in computer technology that we are making in the D.C. Public Schools, innovations which, we believe, will pay off in academic and career success for our students. Our problems are not unique among urban school districts, but it is my strong belief that our solutions are.

Standardized test scores of D.C. Public School children have risen steadily over the past three years. In recently released data, we have seen substantial progress among elementary school students in the mastery of reading and math skills. There are schools in the far Northeast and Southeast sections of the city, areas experiencing the greatest degree of poverty, which are models of student achievement.

The D.C. Public Schools have moved aggressively to improve instructional options for all students, pre-

kindergarten through twelfth grade, as well as those enrolled in adult education. In this regard, there are several major thrusts that we have undertaken. My task today is to inform you of one phase of that thrust...the intergration of computer technology into the educational system.

The following statements are in response to bill, H.R. 1134.

1. Why did the D.C. Public Schools decide to integrate computers into educational system?

The mission of the District of Columbia Public Schools is "...to promote excellence by providing a viable and comprehensive instructional program (pre-kindergarten through twelfth grade) leading to the attainment of knowledge, competencies, and skills which upon completion will enable each student to function as a useful citizen." While the mission of the school system need not change, the strategies used to successfully accomplish the mission must be updated.

The continuing development of new technologies, especially of computer-related disciplines, is revolutionizing American society. The impact of computers spans age, economic, and ethnic lines. In the District of Columbia, with its heavy concentration of white collar industry, computers are used in businesses to manage data and information. As communication devices, they link us with the rest of the country and the world. The Federal and District governments, major local employers, along with their counterparts in the private sector, are now requiring some

degree of computer literacy for many positions that are becoming available. Even during times of high unemployment, the local newspapers carry page after page of advertised positions requiring skills in computer technology.

Our students, as consumers, have felt the impact of computer technology. When making purchases, they have seen electronic scanners "read" product labels without understanding the intricate nature of the transaction. At home, their parents receive computerized utility, telephone, and credit card bills. Clearly, the need for some degree of computer literacy has become necessary "to function as a useful citizen."

Superintendent Floretta D. McKenzie is committed to the implementation of computer technology into the educational system. She has established a Computer Literacy Planning Group which includes teachers, supervisors and administrators, to develop a Computer Literacy Five Year Plan, School Year 1983-1987. I would like to have this Five Year Plan entered into the record.

On March 16, 1983, the D.C. Board of Education approved the following policies:

1. That by the end of School Year 1983-84, student computer laboratories be established in all schools, with attention to security needs.
2. That computer literacy and software selection skills be required for all instructional personnel (teachers, supervisors and administrators) as part

of the five year recertification requirement.

3. That beginning with School Year 1983-84, all new teachers would have to demonstrate computer literacy before being granted permanent tenure.
4. That every student be required to demonstrate a command of the skills that constitute computer literacy before the completion of grade nine, beginning no later than School Year 1987-88.

In order to implement the board policy and in response to this changing environment, the District of Columbia Public Schools is developing a systemwide Computer Literacy Program. The program, proposed to be implemented over the next five years, will require major investments of staff, time, and resources.

The objectives of the Computer Literacy Program are:

- To develop computer awareness among students, teachers, supervisors, and administrators.
- To develop and implement a computer literacy curruculum.
- To design and implement a Computer Training Laboratory.
- To apply computer technology in the local school implementation of the Competency-Based Curriculum through drill and practice, tutorials, problem solving, simulations, and other appropriate techniques.
- To apply computer technology in classroom management,

including record keeping and the tracking and reporting of student progress.

- To apply computer technology to local school

Some of the programs in computer technology that meet the stated objectives are:

- THE WRITING TO READ PROGRAM, is a computer based instructional system funded by the International Business Machines Corporation. This program involves 1500 kindergarten and first-grade students across Washington, D.C. through the use of computers, tape recorders, work journals and typewriters in a special learning laboratory, these students learn to compose and read their own stories.
- THE COMPUTER LITERACY TRAINING LABORATORY, is a computer based instructional system that has trained over 500 teachers, supervisors and administrators in computer literacy.
- THE COMPUTERIZED GUIDANCE INFORMATION PROGRAM, has made guidance information available to all junior and senior high school students, as well as computer programming to all senior high schools.
- THE BELTWAY MICROCOMPUTER/VIDEODISC PROJECT, is sponsored by the U.S. Department of Education. This project involves elementary schools and provides the Education Department and the D.C. school system with the opportunity to study how advanced technology can

be introduced into the school setting.

- o THE NSF SCIENCE PROGRAM, in cooperation with American University provides approximately 50 junior high school teachers with training, equipment and software for using computers for activities in science.
- o THE AUTOMATED INSTRUCTIONAL MANAGEMENT SYSTEM (AIMS), provides teachers in eight elementary schools with automated checklists for each child, classroom grouping reports, and diagnostic information for each child at any time during the school year.
- o THE CAREER CENTERS, offers students computer technology training leading to apprenticeships in: electronic data processing, systems analysis and design, applications and systems programming, data collection and conversion, customer engineering, computer programming, and system engineering.
- o THE SENIOR HIGH SCHOOL COMPUTER-ASSISTED INSTRUCTION PROGRAM, enables students to acquire basic computer literacy skills, access career guidance data files, develop independent study habits and skills essential to success in higher education, and meet an important requirement recently established by the College Board.
- o COMPUTERONICS, reaches 23 schools providing instruction in computer problem solving and computers in society.

By the end of the 1982-83 school year, D.C. Public Schools plan to have installed 1450 microcomputers and minicomputers.

2. What were the difficulties you encountered?

We encountered no real difficulties in developing the Five Year Plan. However, one of the most complicated aspects was in deciding on hardwares and softwares.

3. How would a National Center for Personal Computers in Education have helped you?

A National Center for Personal Computers in Education would have provided us with the state-of-the-art information on computer technology.

4. How would a National Center for Personal Computers in Education help you now that you've started the program?

Such Center could help us to--

(a) develop courseware materials for use in areas in which available courseware materials are inadequate;

(b) develop methods for enabling handicapped individuals to use computers for communication and educational purposes;

(c) establish a computer library that would allow students to borrow personal computers for use outside the classroom;

(d) assess the relative quality and merits of commercially available microcomputers.

(e) develop teacher training materials, inluding computer programs, films, slides, pamphlets, and audio and video cassettes, that will--

(1) instruct educators about personal computers and

their uses to enable them to determine the amount of financial resources and personnel needed to commit to the use of computers in their educational system,

(2) instruct educators in the methods of using computers to enhance the learning experiences of their students in the classroom, in laboratories, and at home, and

(3) instruct teachers in computer programing and in the development of courseware materials;

5. Did you experience problems in finding teachers who were adequately trained to teach?

In terms of classroom student computer literacy instrction, it was necessary to train teachers in the area of computer hardware and software. During the past year, we were able to provide computer literacy training to over 500 teachers, supervisors and administrators.

6. Do you anticipate difficulties in keeping up-to-date with computer advances?

No, we do not anticipate difficulties in keeping up-to-date with computer advances because our contractual arrangements with vendors have provisions to up-date equipment.

In order to carry out the provisions of this bill, it is desirable to have ten to twelve Centers for Personal Computers in Education to provide needed services to state and local education agencies.

We feel that carefully planned National Centers for Personal Computers in Education can be a great assistance to school systems who will enter into computer related instructional activities.

We would like to congratulate Congressman Thomas J. Downey for introducing this bill. I hope that your committee will support this bill for approval which will benefit millions of children in the United States.

We are asking Congress to reaffirm its commitment to improve and expand computer-related instructional programs in this country, so we can continue to prepare our students for the 1980's and 1990's. Thank you.

Dr. JHIN. Thank you, Mr. Chairman, members of the committee, and my distinguished colleagues. On behalf of the Superintendent of the D.C. public schools, Mrs. Floretta McKenzie, I am pleased to join you here today to discuss some of the innovations in computer technology which we believe will pay off in academic and career success for our students in the District of Columbia.

Our problems are not unique among urban school districts, but it is my strong belief that our solutions are.

Standard test scores of D.C. public school children have risen steadily over the past 3 years. In recently released data, we have seen substantial progress among elementary students in the mastery of reading and mathematics skills. There are schools in the far Northeast and Southeast sections of the city, areas experiencing the greatest degree of poverty, which are models of student achievement.

The D.C. public schools have moved aggressively to improve instructional options for all students, prekindergarten through 12th grade, as well as those enrolled in adult education programs. In this regard, there are several major thrusts that we have undertaken. My task today is to inform you of one phase of that thrust, the integration of computer technology into the educational system in Washington, D.C.

The following statements are in response to the bill, H.R. 1134. The mission of the D.C. public schools is "to promote excellence by providing a viable and comprehensive instructional program leading to the attainment of knowledge, competencies, and skills which upon completion will enable each student to function as a useful citizen." While the mission of the school system need not change, the strategies used to successfully accomplish the mission must be updated.

The continuing development of new technologies, especially computer-related disciplines, is revolutionizing American society. The impact of computers spans age, economic, and ethnic lines. In the District of Columbia, with its heavy concentration of white collar industry, computers are used in business to manage data and information. As communication devices, they link us with the rest of the country and the world. The Federal and District governments, major local employers, along with their counterparts in the private sector, are now requiring some degree of computer literacy for many positions that are becoming available.

Even during times of high unemployment, the local newspapers carried page after page of advertising positions requiring skills in computer technology.

Our students, as consumers, have felt the impact of computer technology. When making purchases they have seen electronic scanners "read" product labels without understanding the intricate nature of the transaction. At home, their parents receive computerized utility, telephone, and credit card bills. Clearly, the need for some degree of computer literacy has become necessary to function as a useful citizen.

Superintendent Floretta D. McKenzie is committed to implementation of computer technology into the educational system. She has established a computer literacy planning group which includes teachers, supervisors, and administrators, to develop a computer

literacy 5-year plan, school year 1983-87. I would like to have this 5-year plan entered into the record.

[The document referred to retained in subcommittee files.]

Dr. JHIN. On March 16 1983, the D.C. Board of Education approved the following policies. That by the end of school year 1983-84 student computer laboratories be established in all schools, with attention to security needs. Two, that computer literacy and software selection skills be required for all instructional personnel teachers, supervisors, and administrators as part of the 5 year recertification requirement. Three, that beginning with the school year 1983-84, all new teachers should have to demonstrate computer literacy before being granted permanent tenure. Four, that every student be required to demonstrate a command of the skills that constitute computer literacy before the completion of grade nine, beginning no later than school year 1987-88.

In order to implement the board policy and in response to this changing environment, the D.C. public schools is developing a systemwide computer literacy program. The program, proposed to be implemented over the next 5 years, will require major investment of time, staff, and resources.

The objectives of the computer literacy program are to develop computer awareness among students, teachers, supervisors, and administrators, to develop and implement a computer literacy curriculum, to design and implement a computer training laboratory, to apply computer technology in the local school implementation of the competency-based curriculum, through drill and practice, tutorials, problem solving, simulations, and other appropriate techniques.

To apply computer technology in classroom management, including record keeping and the tracking and reporting of student progress. To apply computer technology to local schools. Some of the programs in computer technology that meet the stated objectives are: The writing to read program, which is a computer based instructional system funded by IBM. This program involves 1,500 kindergarten and first grade students across Washington, D.C. through the use of computers, tape recorders, work journals, typewriters in a special learning laboratory, these students learn to compose and read their own stories at this age level.

Computer literacy training laboratory, which is a computer-based instructional system that has trained over 500 teachers, supervisors, administrators in computer literacy.

The computerized guidance information program for all junior and senior high students. The Beltway Microcomputer/Videodisc Project, which is sponsored by the U.S. Department of Education. This project involves elementary schools and provides the Education Department and the D.C. school system with the opportunity to study how advanced technology can be introduced into the school setting.

The National Science Foundation program, in science, in cooperation with the American University provides approximately 50 junior high school teachers with training, equipment, and software for using computers for activities in science.

The automated instructional management system, which we call AIMS, provides teachers in eight elementary schools with automat-

ed checklists for each child, classroom grouping reports, diagnostic information for each child at any time during the school year.

The career centers. It offers students computer technology training to students in our junior high schools.

The senior high computer-assisted instruction in the area of mathematics, science, and other areas.

Computeronics, which reaches 23 schools providing instruction in computer problem solving and computers in society.

Approximately 1,450 microcomputers and minicomputers are installed in our schools to support the D.C. public schools computer initiative.

We encountered no real difficulties in developing the 5-year plan. However, one of the most complicated aspects was in deciding on hardwares and softwares. How would a National Center for Personal Computers in Education have helped us if it was in existence? A National Center for Personal Computers in Education would have provided us with the state-of-the-art information on computer technology in the area of software selection and hardware selection and curriculum development.

How would a National Center for Personal Computers in Education help us now that we have started our program? Such a center could help us to develop courseware materials, develop methods for enabling handicapped individuals to use computers for communication and educational purposes, establish a computer library, assess the relative quality and merits of commercially available microcomputers, develop teacher training materials, including computer programs, films, slides, pamphlets, audio and video cassettes, that will instruct educators about personal computers and their use, instruct educators in the methods of using computers to enhance the learning experience, instruct teachers in computer programing, and in the developing of courseware materials.

In terms of classroom student computer literacy instruction, it was necessary to train teachers in the area of computer hardware and in software. During the past year we were able to provide computer literacy training to over 500 teachers, supervisors, and administrators.

Do we anticipate difficulties in keeping up to date with computer advances? No, we do not anticipate difficulties in keeping up to date with computer advances because our contractual arrangements with vendors have provisions to up date equipment, to keep up with equipment change.

In order to carry out the provisions of the bill, it is, in my opinion, indeed, desirable to have 10 to 12 centers for personal computers in education to provide needed services to State and local education agencies.

We feel that carefully planned national centers for personal computers in education can be a great assistance to school systems who will enter into computer related instructional activities.

We would like to congratulate Congressman Thomas Downey for introducing this bill. I hope that your committee will support this bill for approval which will benefit millions of children in the United States.

We are asking Congress to reaffirm its commitment to improve and expand computer-related instructional programs as a part of

the educational system in this country, so we can continue to prepare our students for the 1980's and 1990's. Thank you.

Chairman PERKINS. Thank you very much. Dr. Speser, go ahead.

STATEMENT OF DR. PHILIP SPESER, PRESIDENT, NATIONAL INSTITUTE FOR ENTREPRENEURIAL TECHNOLOGY, WASHINGTON, D.C.

Dr. SPESER. Thank you very much, Mr. Chairman. I appreciate the opportunity to express the strong support of the National Institute for Entrepreneurial Technology for this legislation which you are examining today. The Institute is a pro bono publicum group supported by a number of small, high technology companies. I will summarize my testimony and I'm going to focus primarily on the problem of computer literacy, which we see as a threshold problem in the use of computers in education today. But we are pleased that this legislation would do more by encouraging the use of computers as a teaching tool in a variety of substantive areas.

Highly skilled, highly educated labor is the key to our country's economic future in an information-based global society. Just to mention one of the many studies that has been done in this area, in a recent report the staff of the Joint Economic Committee of Congress surveyed 691 high technology companies. The staff concluded the importance of skilled technicians in the JEC survey suggests that investments in human capital to train technical personnel will have a high payoff, particularly in States in the older manufacturing regions with large numbers of unemployed blue-collar workers.

Few would argue that computer literacy will be as important as reading, writing, and arithmetic as we move into the 21st century. There are, of course, a number of projections on needs in this area. Just to mention a few of them, it's estimated that we will need 2 million robot technicians and generate about 1 million new jobs for computer programers by the year 2000.

The American Electronics Association found in a survey of some of its members that they will need approximately 113,000 professionals and 140,000 paraprofessionals by 1985. Unfortunately, we do not have sufficient people to fill these openings and, again, there are a number of studies on that which are mentioned in the full testimony.

Nor should we expect the demand for computer literacy to be limited to jobs in the computer field. It's well known that office automation is changing the jobs of managers and office workers and as automation moves into the factories, production workers will also have to be computer literate.

Just to give you an idea of the extent of the demand for computer literacy, it was recently reported that in Ottawa the Blue Line Taxicab Co. has introduced a computer dispatching system which involves a computerized link between dispatchers and cabs. That made the company's fleet 50 percent more efficient. So, computers are going to be part of every job in the future. The bottom line is simple. The future is here. Workers who are not computer literate are going to find it increasingly hard to find work and companies

without computer literate labor forces will find it increasingly hard to remain competitive in the world market.

Despite the fact that there is a growing market for educational software and hardware, schools are unable to provide adequate training in computer literacy. In an April 7 article in the Wall Street Journal they noted several problems facing educators. Among these were cost of software and hardware, lack of computer literate instructors, lack of instruction of how to train teachers in computer literacy, inadequate planning of software and hardware purchases, and the lack of well-designed, appropriate, software.

These problems are not limited to our primary and secondary schools. The Chronicle of Higher Education recently reported that academia is not only failing to keep up with the new technology and related demands, but is falling further and further behind.

The failure of our educational system to provide its students with computer literacy and thus to take full advantage of computers in instruction has a particularly tragic character. For the failure will be most apparent among the poor and disadvantaged in our society.

I have a 2½-year-old son who already is able to boot up his favorite games and to spell his name because my family is able to afford a home computer. But do we really want to rely upon individual home computer purchases to ensure that all our citizens have an opportunity to become computer literate?

Small high-technology companies have two major reasons for advocating the speedy enactment of this legislation. First, as is well known, small firms are the primary source of new net job generation in the United States. Small high technology firms are also a primary source for training of new job entrants. As a result, the failure of our schools to provide computer literacy will hit these companies very hard.

The need to provide this elementary training will in turn cut down on funds that these companies can use for R&D and innovation, at which small high technology companies excell.

H.R. 1134 will benefit small high technology firms by providing a long needed focal point for educators seeking guidance and advice on computer literacy and the use of computers as teaching tools for substantive courses. Small firms rely upon our country's educational institutions to provide their workers with basic skills. It would be a major incentive to the development of high technology if our educational institutions could also provide all students with computer literacy and advanced skills in education.

Second, it will come as no surprise to anyone that computer hardware and software are still industries noted for the large numbers of small high technology companies they contain. A major reason why schools face difficulties in obtaining high quality cost efficient hardware and software is that the market for these pro ects is highly disaggregated and suffers from a lack of adequat communication channels between small firms and educators.

The primary factor behind the inability, rather, of small firms and schools to find each other is the lack of an adequate focal point for educational hardware and software. While most school systems have heard of IBM or Control Data, how many school systems have heard of Software Professionals of Fort Wayne, Ind., just to men-

tion one example? Yet this firm is an active producer of educational software and software for training handicapped persons.

By serving as a focal point for the use of computers in education, the National Centers for Personal Computers in Education that this legislation establishes will aid small high technology firms in developing the high quality hardware and software that educational institutions need.

Under section 393-B-16, the centers are directed to inform the industry of the educational system's needs and to inform educators of developments in industry. Further, under section 393, the evaluation, demonstration, and information programs of the centers will provide small firms with a forum in which they can demonstrate the quality and the utility of their products to educators who might not otherwise have a chance to benefit from the innovation occurring in this sector of our economy.

Indeed, we would recommend only one minor refinement to this legislation. Since numerous small high technology firms are actively involved in performing the functions that this legislation envisions for the centers, we would urge the subcommittee to include language in the legislation or the accompanying report clarifying that the grant competition envisioned by section 394 will be open to both for profit and nonprofit entities. We urge this refinement because past experience has indicated that bureaucrats frequently suffer from an inertia which leads them to quietly deep six proposals from small high technology companies on the grounds that Congress, in quotes, "really meant that only nonprofit entities should be allowed to compete for research or educational program funding."

To conclude, we are convinced that this bill would provide a long-needed focus for efforts to provide computer literacy for all our citizens and to encourage the use of computers in teaching substantive subjects.

[Prepared statement of Dr. Speser follows:]

PREPARED STATEMENT OF PHILIP SPESER, J.D., PH.D., NATIONAL INSTITUTE FOR ENTREPRENEURIAL TECHNOLOGY

Mr. Chairman and Members of the ubcommittee, I appreciate the opportunity to express the National Institute for Entrepreneurial Technology's strong support for the legislation you are examining today. In our testimony I am going to focus my remarks on the problem of computer literacy, which we see as the threshhold problem in the use of computers in education. But we are pleased that this legislation would do much more by encouraging the use of computers as teaching tools in a variety of substantive areas.

THE NEED FOR COMPUTER LITERATE WORKERS

Highly skilled, highly educated labor is the key to our country's economic future in an information-based global society. For example, Lynn E. Brown, Assistant Vice-President and Economist fo the Federal Reserve Bank of Boston and Professor John S. Heckman of Boston College have noted that the key factor in the development of high-technology industries in New England was that region's pool of appropriate labor. In a recent report, the staff of the Joint Economic Committee surveyed 691 high-technology companies. The staff concluded: "The importance of skilled technicians in the JEC survey suggests that such investments in human capital [to train technical personnel] will have a high payoff, particularly in states in the older manufacturing regions with large numbers of unemployed, blue collar workers."

Few would argue that computer literacy will be as important as reading, writing, and arithmetic as we move into the Twenty-first Century. The Washington Post noted in a September 26, 1982 article that the country could employ more than 2 million robot technicians and generate around 1 million new jobs for computer programmers by the year 2000. Yet we currently do not have adequate supplies of labor to fill these positions. The National Science Foundation estimates that shortages of 115,000 to 140,000 computer specialists are likely to exist by the year 1987 alone. A survey of their members by the American Electronics Association found that the 671 responding companies will need 113,098 professionals and 140,002 paraprofessionals by 1985. The U.S.

Department of Labor reports that overall employment in the computer field will double again by 1990--after already doubling during the 1970s. The demand for computer service technicians is projected to grow by 154% between 1978 and 1990. Job openings for computer and peripheral equipment operators should average 46,200 per year.

Nor should we expect the demand for computer literacy to be limited to jobs in the computer field. In Advances In Automation Prompt Concern Over Increased U.S. Unemployment (May 25, 1982), the GAO emphasized the importance of computer literacy for jobs not normally associated with computer operation. The report states: "Several occupations will change because of the implementation of electronic automation. Persons remaining in thoseoccupations will be performing tasks not previously done, some of which will require new skills that can be learned. For instance, managers might be required to type, production workers, instead of performing actual manufacturing and assembly work, will tend to automated equipment." The extent of computerization was indicated by a July 7, 1982 article in the Wall Street Journal, which described the implementation of computer dispatching in Ottawa's Blue Line taxicabs. According to the company, computer dispatching, which involves a computerized link between the dispatchers and the cabs, has made the company's fleet 50% more efficient.

The bottom line is simple: The future is here. Workers who are not computer literate are going to find it increasingly hard to find work. Countries without computer literate labor forces will find it increasingly hard to remain competitive in the world market.

THE INABILITY OF SCHOOLS TO MEET THE NEED FOR COMPUTER LITERATE WORKERS

There is an increasingly attractive market for educational software and hardware. Venture magazene estimates that by 1986, educational software sales alone could be a $250 million market, assuming that educational software maintains the same proportion of current sale for all microsoftware.

Despite this growing market, schools are unable to provide adequate training in computer literacy. In an April 7, 1983 article, "Many Schools Buying Computers Find Problems With Using Them," the Wall Street Journal noted several problems facing educators. Amoung these were: costs of software and hardware, lack of computer literate instructors, lack of instructional time to train teachers in computer literacy, inadequate planning of software and hardware purchases, and lack of well designed, appropriate software.

These problems are not limited to our primary and secondary schools. In "Colleges Struggling to Cope with Computer Age," The Chronicle of Higher Education notes: "...experts in computing and higher education [say] on', a relatively few campuses are

successfully adapting to the latest technological developments. For the most part, they say, academe is not only failing to keep up with the new technology and related demands, but it is falling further and further behind."

The failure of our educational system to provide its students computer literacy and thus to take full advantage of computers in instruction has a particularly tragic character. For the failure will be most apparent amoung the poor and disadvantaged in our society. Indeed, as the government, industry, and schools increasingly turn to using computers to administer standardized tests (Wall Street Journal, April 18, 1933), the impact of computer literacy on educational and career opportunities will become all pervasive. I have a two and one-half year old son who already is able to "boot up" his favorite games and to spell his name because my family is able to afford a home computer. But do we really want to rely upon individual home computer purchases to ensure that all our citizens have an opportunity to become computer literate?

THE INTEREST OF SMALL HIGH-TECHNOLOGY FIRMS IN THIS LEGISLATION

Small high-technology companies have two major reasons for advocating the speedy enactment of this legislation. First, as is well known, small firms are the primary source of new net job generation in the United States. Small firms also are a primary source of training for new job entrants. As a result, the failure of our schools to provide computer literacy will hit these companies very hard. The burden of providing training for computer literacy will fall upon companies with the least disposible income to dedicate to this task. The need to provide this elementary training will, in turn, cut down on funds that could be used for R&D and innovation--at which small high-technology companies excel.

H.R. 1134 will benefit small high-technology firms by providing a long-needed focal point for educators seeking guidance and advice on computer literacy and the use of computers as teaching tools for substantive courses. Small firms rely upon our country's educational institutions to provide their workers with basic skills. It would be a major incentive to the development of high-technology if our educational institutions could also provide all students with computer literacy and advanced skills and education.

Second, it will come as no surprise to this Subcommittee that computer hardware and software are still industries noted for the large number of small high-technology companies they contain. A major reason why schools face difficulties in obtaining high-quality, cost-efficient hardware and software is that the market for these products is highly disaggrigrated and suffers from a lack of adequate communication channels between small firms and educators.

The problem of marketing has been addressed in a number of

studies. For example, The NSF reported (in Problems of Small High-Technology Firms, NSF 81-305) that approximately 60% of a national sample of such firms had major problems associated with making the transition from research and development to marketing. Respondents mentioned such factors as inexperience with marketing and market research and the high cost of national advertising as underlying causes of the problem. In a preliminary survey of small high-technology companies that the Institute conducted in the Baltimore-Washington Corridor, 36.5% of the respondents mentioned marketing problems when asked: "What is the most pressing problem for your firm today?" (Only lack of capitalization was mentioned by a higher percentage of respondents--46.3%.)

The primary factor behind the inability of small firms and schools to find each other is the lack of an adequate focal point for educational hardware and software. While most school systems have heard of IBM or Control Data, how many school systems have heard of Software Professionals, Inc. of Fort Wayne Indiana. Yet this firm is an active producer of educational software and software for training handicapped persons.

By serving as a focal point for the use of computers in education, the National Centers for Personnel Computers in Education, that this legislation establishes, will aid small high-technology firms in developing the high-quality hardware and software that educational institutions need. Under section 393 (b)(16), these Centers are directed to inform the industry of the educational systems needs and to inform educators of develcpments in industry. Further, under section 393, the evaluation, demonstration, and information programs of the Centers will provide small firms with a forum in which they can demonstrate the quality and utility of their products to educators who might not otherwise have a chance to benefit from the innovation occuring in this sector of our economy.

Indeed, we would recommend only one minor refinement to this legislation. Since numerous small high-technology firms are actively involved in performing the functions this legislation evisions for the Centers, we would urge the Subcommittee to include language in the legislation, or the accompanyin[illegible]port, clarifying that the grant competition envisioned by se[illegible]394 will be opened to both for-profit and non-profit enti[illegible]. We urge this refinement because past experience has indicated that bureaucrats frequently suffer from an "inertia" which leads them to quietly deep-six proposals from small high-technology companies on the grounds that Congress "really meant" that only non-profit entities should be allowed to compete for research or educational program funding.

To conclude, we are convinced that H.R. 1134, the National Centers for Computers in Education Act, would provide a long-needed focus for efforts to provide computer literacy for all our citizens and to encourage the use of computers in teaching substantive subjects.

Chairman PERKINS. I'd like to ask you a question. How can such a center or centers on computers be funded as envisioned in this bill to give advice to local school districts regarding computers without us winding up with a federally funded center giving advice, preferring one computer over another, or one company over another? Should the Federal Government do that?

Dr. SPESER. I believe that there is a meaningful functions for the Federal Government in providing quality control checks for educational hardware and software projects. It's quite frequent in the scientific area that quality control is provided by, for example, peer review panels and so on before funds are expended in research, and I don't see where this would be that much different if you had adequate staffs in the centers. I'm assuming, of course, that the centers are staffed by highly competent people.

Chairman PERKINS. Mr. Ackerman? Go ahead.

Mr. ACKERMAN. I'm curious to find out how IBM was encouraged to make the grant in Washington, D.C.

Dr. JHIN. Our superintendent, Floretta McKenzie, is the captain of the public/private partnership program. Therefore, when she took over she contacted numerous business sectors and encouraged them to be part of instructional training and implementation teams. That is how IBM was able to participate in our program.

Mr. ACKERMAN. Have they been doing this in different parts of the country? Do they find this advantageous to their own interests?

Dr. JHIN. I'm sure they also have a similar program in other parts of the country. But we are very fortunate to participate. I am sure it will be beneficial to their long range planning.

Mr. ACKERMAN. The reason I asked the question is because it seems to me that there are school districts throughout the country that are not going to be able to afford getting into this new technology for a long time to come. If it is advantageous for private industry to make this outreach or to be encouraged, we should find out how this is done so that all parts of the Nation can be equally advantaged.

Dr. JHIN. Yes. I think it would be very useful. Of course, I am sure you are aware of the Apple Co. giving one computer to every school in California and I'm sure they have the goal of reaching more people through this donation.

Dr. BRAUN. May I make a comment on that?

Mr. ACKERMAN. Yes.

Dr. BRAUN. A year ago the National Science Foundation, in partnership with a number of the microcomputer manufacturers, had a program where NSF and the private companies each put up about $900,000 in a grant program to school systems around the United States to do research on using computers in education. So, that would be a good model for that.

Mr. ACKERMAN. They wanted to stimulate business for themselves?

Dr. BRAUN. I'm sure that's their ultimate reason, I'm sure.

Mr. ACKERMAN. Well, that's good for us to know.

Dr. BRAUN. Yes. By the way, there are two such programs with IBM on Long Island, one in Roslyn and one in Deer Park.

Dr. JHIN. And beginning this fall they are going to have four programs, this time in terms of teacher training, one in New York, ob-

viously, because that's where the IBM headquarters are located, and one in California, and one in Florida, and hopefully the D.C. Public Schools can also participate in this teacher training program.

It's obvious, Mr. Ackerman, that it's like the Chevrolet Co., Ford Motor Co., Chrysler Co., used to provide and they are still doing it, their automobiles for drivers education. Why? If youngsters are used to the automobile they will buy those things. So, these computer companies are providing these demonstration projects and teacher training programs hoping that that product, we will be more familiar with it and we may be more leaning toward buying their product.

But, of course, such an area, the National Center for Personal Computers in Education, could help us, help the local school systems who do not have technological know-how to distinguish from high power sales as well as some of the materials may not be suited for instructional programs.

I think the national center could provide that kind of technical assistance to local and State education agencies.

Mr. ACKERMAN. Do we have any idea yet which youngsters are becoming computer literate or more predisposed to becoming computer literate? It's my thinking that children from more advantaged homes learn how to read faster because there are books throughout the shelves in their house. Children who take typing courses in school will become good typists and they're the ones whose parents can afford a typewriter at home. Are we finding that kids who have Ataris and a pocketful of quarters to throw away at these arcades are the kids who are becoming computer literate and more disadvantaged kids really aren't getting into it, or is there no correlation between that and this industry?

Dr. JHIN. I'm sure there are correlations. That is why the D.C. Public Schools, in order to eliminate that problem, this year we are going to provide a computer in each elementary school, 8 to 10 microcomputers will be installed in a lab in each elementary school in our D.C. public schools. And also we are going to provide computer camps for students in our school system. So, we have tried to meet their needs and I think it's very interesting that those children from economically-deprived areas will be academically also deprived as a result.

Mr. ACKERMAN. Would you be able to keep and correlate data between reading levels of children and the math levels in certain classroom areas and correlate that between computer literacy?

Dr. JHIN. Yes, sir. We are hoping to have the data related to those students using the computer as part of their tool and those who do not.

Mr. ACKERMAN. Thank you.

Mr. PACKARD. I appreciate the testimony that you've given on the importance of computers in our educational system. I think you're right. It is, certainly, the area of the future and important that we keep our young people abreast of it.

I am concerned, however, about setting up a new national center for the computer education program when we have existing organizations through which I think this kind of a program could and normally would be funneled. We have the National Institute of

Education, a research arm of the Department of Education. We have also the National Science Foundation, the National Diffusion Network, which comes under the Secretary of Education, all of which could play a role in such a program. In your judgment, why is it important that we set up a new structure whereby we might dilute some of the funds that would get right to the children, and the teaching process?

Dr. SPESER. If I can just speak to that. The programs that I'm most familiar with in the NSF or in the Department of Education and so on, are mostly directed at research. That is, they are looking at what factors would make for good hardware and software in the educational area, what kinds of configurations might be attractive. There is a great weakness in the area of what is commonly called "technology transfer". As I mentioned in the testimony, there's a gap at present between people who have the product developed and people who are interested in obtaining the product for educational software or hardware that can run educational software.

And there are two factors involved with it. One is since a lot of small companies are involved in making these types of products, they cannot go to the D.C. School System and say, "Let us put a computer in every one of your schools and we're going to give you all of this software," and so on. There's just not that kind of capital in the small companies, as we are familiar.

The second problem is from the standpoint of an educator dealing with a small company. If they deal with an IBM they can say, OK, if the software is bad I can probably go back and beat on the top of IBM and I'm relatively convinced that there's not going to be a problem because IBM's got to protect its corporate reputation, and all those kinds of considerations.

In a small company it's different. They are not as familiar with the small company so they're looking for some kind of external indicator that the software really or the hardware really does what the company says it does, and that's where a center like the one that's proposed here would be very instrumental because it provides an objective tester for the quality of claims that are made by companies. We welcome that kind of an objective testing because we're convinced that the products coming out of small high technology firms are far more innovative than you're going to see coming out of a large firm.

Mr. PACKARD. I still do not see why, this center could not become another arm of an existing organization rather than setting up a new network or a new structure. I think a large portion of the cost of setting up these new and innovative programs tends to go to setting up a new structure. If there is an existing structure I certainly would hope that we would be able to incorporate the same priorities and the same goals of the new program under an existing hierarchy.

You also mentioned in your testimony, that the primary and secondary schools probably would be the ones that would participate in this computer program. How far down in the primary levels do you feel it would be most cost effective in terms of providing the children with computer education?

Dr. SPESER. I feel very strongly that as far down as you can take it is where it belongs, and I feel that primarily on the basis of my

own experience with my own son, and as I mentioned, I have a 2½-year-old son who has already become more computer literate than some of the people that we've brought into our organization when we first brought them in.

The computer is a funny kind of teaching tool because as many people say, it's important to give positive reinforcement to a child when they're learning. The computer is wonderful for positive reinforcement. If you do it right, you see the results immediately, and it's just a phenomenal teaching tool for very young children.

Mr. PACKARD. I think the key words of my question were cost effective. We know that there are shortages in school finances and in funding these kinds of programs. We must evaluate in terms of where the dollar can best be spent for the greatest amount of mileage.

We know that we've been negligent for years in high technology and math and science programs. We've already started to change that. I think that the real question now is are the dollars more valuable at the first and second grade level or are they more valuable in terms of 8th, 9th, 10th grade levels?

Dr. SPESER. Again, I'm speaking from my own predispositions. I don't have hard data that addresses this but my gut feeling is that it would be more valuable at the first, second, and third grade level because at that point you really have a lot of curiosity in the child and you want to encourage them to become familiar with the machine and so on.

Once they're, in a sense, hooked on working with computers, they will want to continue doing that and they will begin to seek out ways of doing it as they progress through their educational career. If you wait until far more downstream at the college level, say, you've already lost a lot of people and you begin to run into the problem of fear of computers and so on.

Mr. PACKARD. In order to get them interested in computer systems, do you envision this program as somewhat of an Atari-type of game process or an instructional process. If it is the latter, I have to come back and ask at what level of education, what level of understanding, can that instruction best be directed?

Dr. JHIN. In our school system in Washington, D.C. public schools, we do have this program called writing to read. That is the program designed for kindergarten youngsters as well as first graders. The reason D.C. public schools decided to go with this level is we have the shortage of science and mathematics persons in this country, and engineers. The reason is that by the time they reach the junior high level, once kids get turned off about math and science because of a lack of proper instruction, and lost interest, so we are trying to—and also they have a fear of mathematics and science.

So, in terms of computer technology we want to give them the feeling that the computer can be their friend, that it will benefit them. So, we were very successful in our plan.

The other day I went to visit Congress Heights write to read program. They have three full stations plus places—they have computer program instruction dealing with certain words. Like they have a pet running around and c-a-t underneath. Then they have a bird and the spelling of b-i-r-d.

Then next they go to another work station and the last station they come to, it used an actual IBM typewriter to write whatever they want as they wish. The spelling may be wrong. But I was surprised to find kindergarten youngsters spelling emergency correctly. He was writing, "What do you do when there is an emergency?" And he had a perfect spelling, a first grader.

So, this sort of incident is happening over and over and we feel those kids who went through this program will never be afraid of computers.

Dr. BRAUN. I think there is a great deal of evidence that children, very young children, learn foreign languages at a much more rapid rate than older children do. When I was a child we were introduced to foreign languages in high school. The time to teach kids foreign languages is in elementary school and the time to teach them about computers is exactly in the same place.

Mr. PACKARD. One last question. To what extent does the proposed legislation incorporate or require participation of the private sector, which perhaps is far more advanced in terms of teaching and developing computer systems than is the school system?

Dr. SPESER. If I can just speak to that, there are passages in the legislation, clauses that explicitly refer to establishing linkages between the educational system and the private sector. So, we do not have any real concern about the involvement of the private sector in this legislation other than the small thing that we mentioned, that we'd like it clear that section 394 enables both profits and nonprofits to compete for the grants so that they go to the highest quality organization, whether it's in the private or the nonprofit sector.

Mr. PACKARD. But there is no requirement for matching funds in terms of private sector use, or search for private sector involvement in the process?

Dr. SPESER. No; but I think you would see a significant amount of that because the types of activities that are being—and some of the activities it just wouldn't be appropriate to have matching private sector funds. I know that the firms that we're involved with would be somewhat upset if a center that was evaluating an objective evaluation of software, say, was funded by IBM. It would lead to some concerns about the objectivity of the evaluation despite the best intentions.

On the other hand, when you're talking about developing courseware, I would envision that something very similar would happen there, as happens at, for example, the National Bureau of Standards where a scientist from the private sector comes to the Bureau to work on advanced technological problems with scientists from the Bureau and Bureau scientists going to company research laboratories, and I would envision the same kind of thing would happen here.

It's a relatively modest level of funding that's being sought for these centers, so they're going to be compelled to go out and seek private sector support for appropriate activities.

Mr. PACKARD. Of course, it's the beginning of a new program and modest levels of funding at the beginning often develop into major fundings downstream.

However, the same concerns that IBM would have if IBM equipment were used in a voluntary or on a cooperative basis with private enterprise, would be magnified, in my judgment, if it were by tax dollars, that they were still using those same computer software or hardware.

So, I think that that same attitude could prevail irrespective of whether funding was from the private sector or tax dollars.

I suppose you understand my concerns. I am certainly not speaking in any way against the need. The questions are how to implement the program how to get the most for the dollar, and how to target it to those children who would receive the greatest amount of benefit. This is where I think we'll have to address our concerns.

Dr. BRAUN. May I make a comment on that last point?

Mr. PACKARD. Sure.

Dr. BRAUN. I think the important concept in these centers is that there is an aggregation of resources, both financial and intellectual. There are not very many people in this country yet who can do the kinds of things that are needed in this center. They are now diffused all over the United States and these centers would coalesce those intellectual resources and by the synergy of their being in a single location they would generate a great deal more of useful information for the schools than is now done by those same people.

Mr. PACKARD. One last comment before I conclude. That is, I would also hope that any such program would not simply be a game-oriented type of program that—our children are caught up with now—to the point where it really does not focus on an educational process.

Dr. JHIN. I would like to make one more comment. I think that in order for such national centers or center to be effective, there should be spread all over the country, like maybe possibly 10 to 12, so that local school systems and State education agencies could go to this center for assistance when it is located in one isolated place, really, if it's in Washington for people from California it's difficult to get assistance.

So, I would also like to recommend that.

I think we have more successful programs and the resources, softwares. All we need is someplace to coordinate and right now it seems that coordination is missing.

Mr. PACKARD. Thank you very much.

Mr. ACKERMAN. OK. I'd like to thank the panel for their participation. The hearing is concluded and the subcommittee stands adjourned subject to the call of the Chair.

[Whereupon, at 10:50 a.m., April 21, 1983, the hearing was recessed, subject to the call of the Chair.]